POWER

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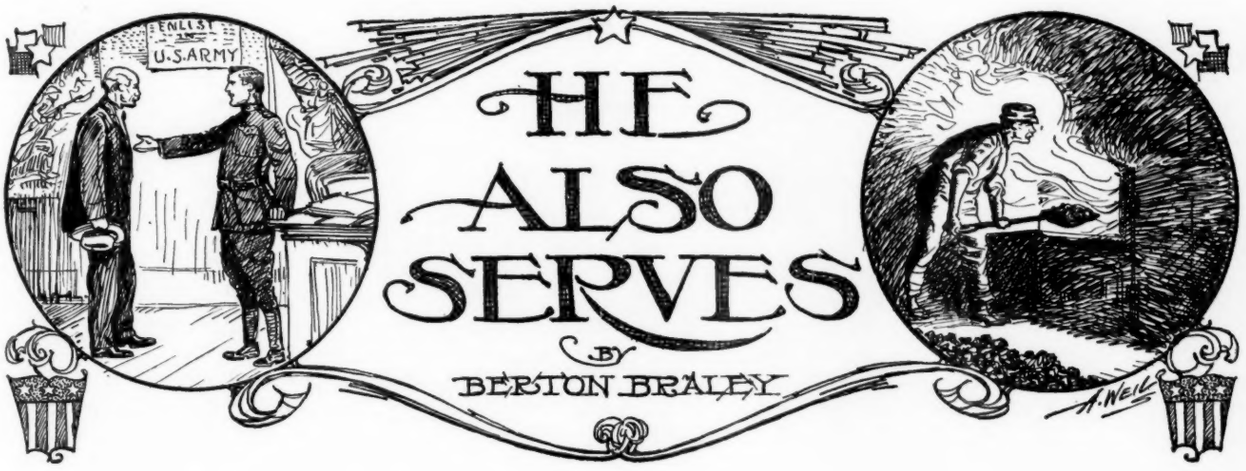


Seemed sort of hard, at first, I couldn't go
To fight beside the boys acrost the sea.
I tried, all right, but sergeant he says, "No.
You're over age for soldierin'," says he.
"Look here," says I, "I may be over age,
But see this chest, these muscles, an' these hands—
I ain't too old to earn a fireman's wage,
Why won't I do to fight in furrin' lands?

"The kids is growed," I says, "an' Jim an' John
Is over there; I got a bit laid by,
The wife she wouldn't starve while I was gone,
I'd like to fight with my two boys, an' I
Could do my bit, I know." The sergeant smiles,
"I know you could," he says, "but man alive,
I'd get called down in fifteen diff'runt styles
If I took you—you're over forty-five."

So I goes back to work—not feelin' gay,
An' thinkin', "Hell, it's fierce to be so old!"
But then it sort of comes to me next day
That after all, the guys that are enrolled
As soldiers ain't the only ones that serve,
An' us at home can do our bit, all right.
I guess a man can use his strength an' nerve
To *work* for Uncle Sam, as well as fight.

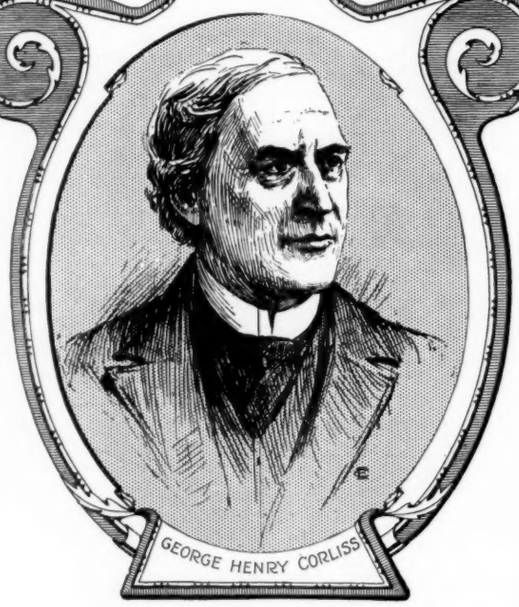
So now I watch my fires an' save my coal
(That's helpin', when you think what fuel means),
An' do my job with all my heart an' soul
Makin' the steam that's drivin' our machines;
For it's machines that's gonta win this war
Cuttin' an' shapin' guns an' other things
That's used to aid our boys who're fightin' for
The old U. S. against them Prussian Kings.

Here in the basement where the boilers hum
I have enlisted till the war is won,
There ain't no music of a fife an' drum
To cheer my spirits while my work is done,
But with my shovel an' my slice-bar, too,
I toil an' sweat an' never make a yelp,
I'm in the service till the game is through,
Too old to fight, but not too old to help!

The "One Hundredth Anniversary" of George Henry Corliss

By H. F. Mueller

CHIEF ENGINEER of WASHBURN-CROSBY MILLS, MINNEAPOLIS, MINN.



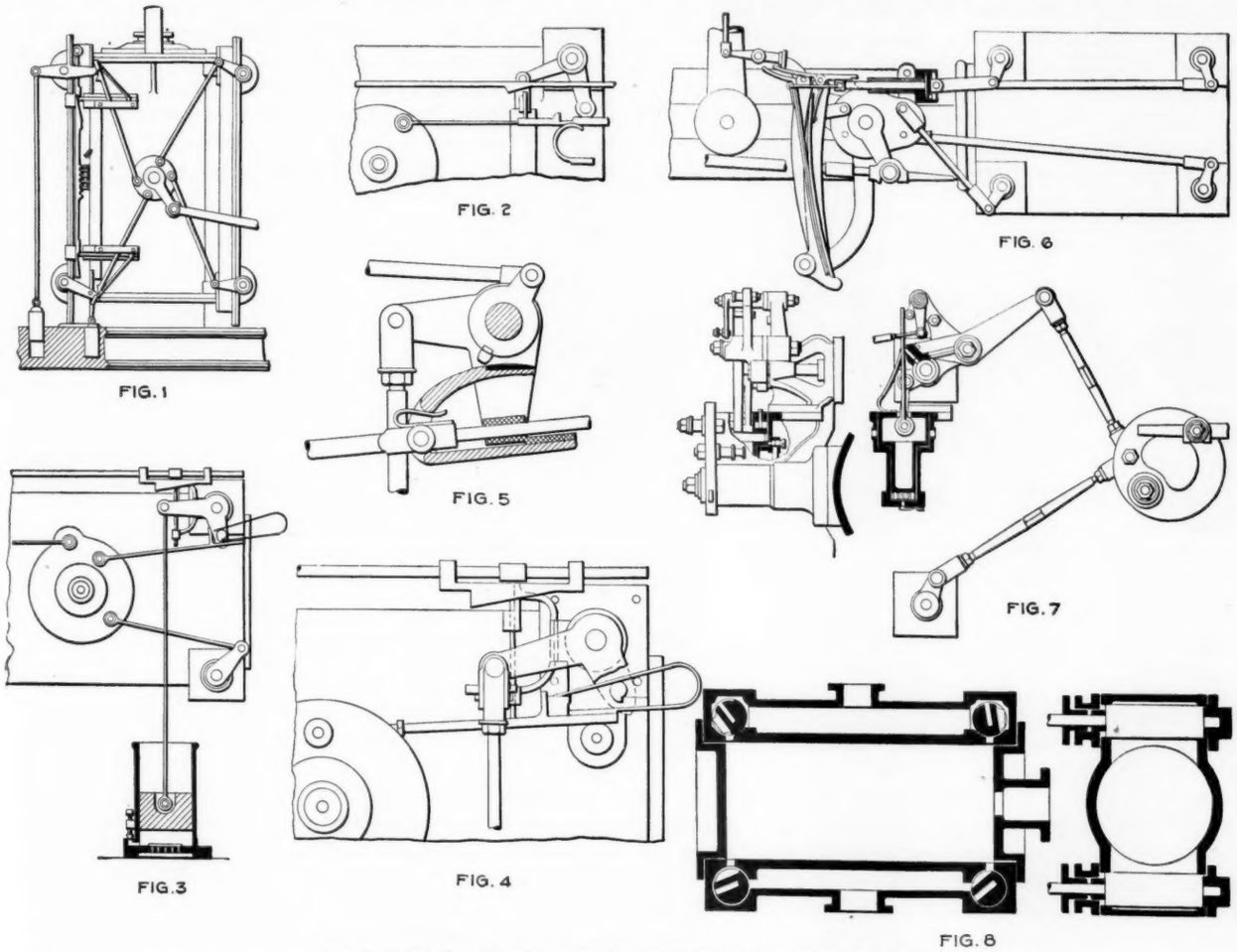
GEORGE HENRY CORLISS was born in Easton, N. Y., June 2, 1817. He was the son of a doctor, and although he did not follow the footsteps of his father, trying to make people healthy, he became nevertheless a doctor indeed, a doctor of the engineering profession. He was a man of strong and determined character, who could not only make decisions but carry them out in spite of difficulties and resistance. He was a religious man and always polite and kind and anticipatory in his manners. He lived in a plain cottage near his factory and devoted his spare time to his family. There alone he sought and found recreation and enjoyment. He was very fond of the lawn around his house and took great care of it. "Such a lawn as mine," he would declare boastfully, "cannot be found in the whole United States." Corliss received many honors and appreciations. At every exposition he received the highest awards even if he had no exhibit at all; for instance, at the World's Fair in Vienna, he received the Gold Medal for the reason that most of the engines exhibited were built after the Corliss patents. In 1870 The American Academy of Arts and Sciences awarded Corliss the Rumford Medal.

Since James Watt's time no name has been so often or so intimately connected with the steam engine as the name of Corliss. The work of this great American marked a new step in the development of the steam engine. His improvements revolutionized the steam-engine business and gave his name an everlasting fame.

He died in February, 1888, after a short illness, thirty years ago, but his engine has held its place at the head for nearly three-quarters of a century. Many and various and some fearful and wonderful attempts have been made at various times to produce an engine to supersede it, but so far with little success, and through all these years, the Corliss engine has maintained its proud position as the standard mill and factory engine. We first find young Corliss working as a clerk in a store. Next it is reported that he erected a general merchandise outfit of his own in a small country town, but, at about 22 years of age, realizing that the monotony of the village threatened to dull his senses, he shut down that plant, dismantled it, went to a larger city and found employment in a shoe factory. The noise of the factory, the humming sound of the moving machinery was classic music in the ears of young Corliss. He remained in the shoe factory about four years, and his remarkable ability for technic and construction soon became known. He made here his first invention, a sewing machine, and it was to get it built that Corliss left the shoe factory and went to Providence, R. I., the only place at that time where such work could be done. He arranged with the firm of Fairbanks & Bancroft, then doing a machine and engine business, and started at once with the perfection of his sewing machine. Fairbanks & Bancroft, however, soon discovered that Corliss was a man they could use to great advantage in their own employ, and as they did not care to manufacture sewing machines they closed the dampers on that work and persuaded Corliss to disconnect himself from the sewing machine and devote his time and attention to projects which they had on hand. Corliss changed over and started in a new direction. He made good, so splendidly good that inside of a year Fairbanks & Bancroft riveted young Corliss solidly to their shops by making him one of their partners. It was at this time that Corliss conceived the improvements which revolutionized the steam-engine business and made his name a household word to every engineer in the country. He made a radical departure from the customary engine design of those days by constructing a cylinder with two valve chests, one for the steam inlet and one for the exhaust outlet. He used four valves in his cylinder, one at each corner. He designed a wristplate oscillated by an eccentric, to which the four valves were connected. He designed a valve-releasing gear with dashpots to close the steam valves quickly. He attached the governor to the valve mechanism and designed an entirely new engine frame.

The first engine of Corliss design, started in February, 1848 (Corliss was then 31 years old), was a 260-hp. walking-beam engine; the cylinder, shown in Fig. 1, measured 22 in. diameter by 72-in. stroke. The inlet valves are at the left and the exhaust valves at the right. The inlet valves on the first few Corliss engines were flat and were opened and closed by small shafts with

racks and pinions operated from the central wristplate. The motion rod effecting the opening had a hook on one end, held by a spring against the valve shaft, which connected to the lever and so opened the valve. After the motion rod had traveled a certain distance, it struck a wedge-shaped arrangement which disengaged the hook, and the valve was closed by a weight attached to the valve-shaft or hook lever. The cutoff was not under the influence of the governor, but set by hand. The first engine having the cutoff controlled by the governor and having cylindrical oscillating valves, Fig. 2, was built in 1850.



FIGS. 1 TO 8. EARLY TYPES OF CORLISS VALVE GEARS

Fig. 1—The first Corliss cylinder and valve gear, 1848. Fig. 2—Valve gear of 1850. Fig. 3—Valve gear of 1851, dashpot taking shape. Fig. 4—The inclined gear of 1852. Fig. 5—"Crab-claw" gear of 1858. Fig. 6—Known as the spring-lever gear, put out in 1859. Fig. 7—Corliss' latest design, 1875. Fig. 8—Familiar Corliss cylinder and valve shown in section.

In Fig. 3 the springs holding the inlet motion rods in their respective places are fastened directly to the rods. The valves are closed by weights in smooth cylinders, but cushioned by air entrapped at the bottom of the little cylinders.

For a long time the gear shown in Fig. 4 was considered the best Corliss valve gear, and many engines were built of that design. Fig. 5 is the so-called crab-claw gear. Corliss very seldom used this gear, but some other engine builders did, especially William Harris, of Providence, R. I. It was frequently called the Harris-Corliss gear. Weights were used to close the valves on this gear.

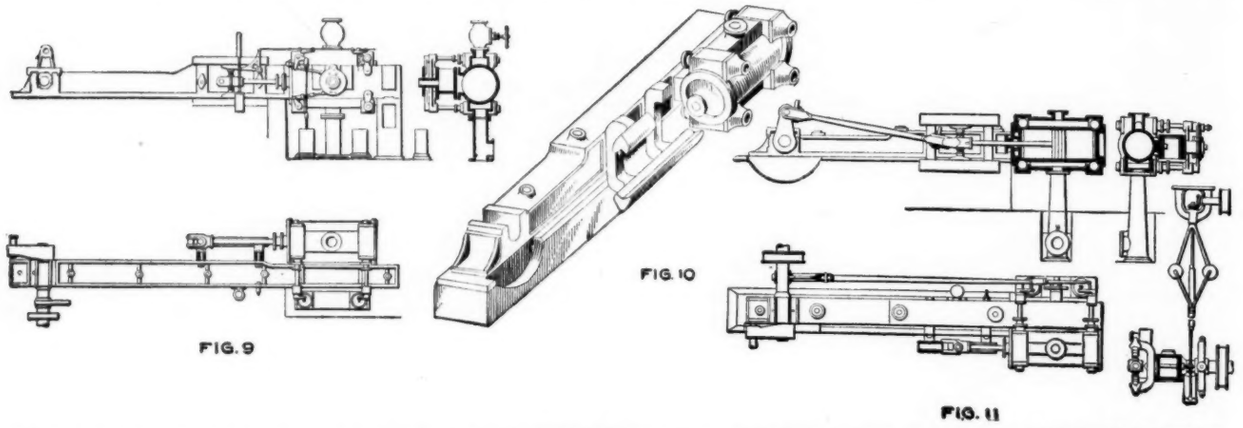
Fig. 6 is the so-called spring-lever gear, intended to do away with weights. This gear did not prove satisfactory. The springs broke frequently and were sometimes replaced by weights. A few engines were built with coil springs to close the valves, but the springs all gave trouble and Corliss fell back to the old crab-claw gear. Fig. 7 shows Corliss' latest design. Here the valves are closed neither by weights nor by springs, but by the pressure of the atmosphere on a dashpot that has a differential piston. The lower, or smaller, end, packed with a cup leather, acts as a vacuum pump; the upper or larger piston serves as an air cushion. A small check is located at the lower end of the vacuum cylinder for the escape of air leakage. To prevent the cast-iron piston striking hard metal against metal in case the vacuum is too strong and not enough air is admitted for cushioning, a leather washer is placed underneath the dash piston. This was the first valve gear designed permitting adjustment of the valves while the engine is in operation. The motion rods are threaded right and left. Fig. 8 is a sectional view of the Corliss cylinder showing the position of the valves.

Engineers laughed at the new machine and ridiculed Corliss and his inventions. They had a couplet in circulation running this way:

Levers, links and motions various,
Endless jimcracks all precarious.

But by-and-by the Corliss inventions were appreciated and Corliss was praised to the skies.

Within the year 1848 or early in 1849 Corliss had completed and had in operation two more engines like the first. Those three engines were so successful that tracts of land were purchased and extensive shops erected for the manufacture of engines. The engines installed gave excellent satisfaction, and the prospects for more and greater business were splendid, everything worked so nicely; then something serious happened which almost shut down the whole plant. Corliss took out a patent in 1849, after he had built three engines, but with this first patent troubles of large dimensions arose. Seven years prior to this a man by the name of Sickles had taken out patents on steam-engine improvements and when he heard of the Corliss patent and the wonderful success of his engine, he started to investigate and seemed to discover that the Corliss patent was very much like that of his own. Legal proceedings were the consequence, and before young Corliss realized the situation he was confronted with a high-pressure lawsuit.



FIGS. 9 TO 11. SOME EARLY TYPES OF CORLISS ENGINE FRAMES, SHOWING THE GRADUAL EVOLUTION FROM BEDPLATE TOWARD THE GIRDER FRAME

Sickles, in his legal proceedings, not only tried to prevent Corliss from manufacturing these engines, but also directed his threats against those using the engines, so Corliss had to defend himself and his customers at the same time. He had both hands full. Lawyers of the highest ability were employed on both sides, and the litigation was carried on with much bitterness. The case was tried before various juries and judges, and the fight extended over a term of 15 years. Finally, the Corliss patents were fully sustained in all points, and thenceforth, until their expiration in 1870, Corliss had the field to himself. The legal fight cost Corliss $100,000.

Many feel a certain sympathy for Sickles, who came so near achieving a great success yet missed it. The inventions of Sickles and Corliss were as different as the two men. Sickles invented an improved method of lifting, tripping and cushioning poppet valves. It seems that he had no other valve in mind; in fact, his claims are so drawn as to exclude all others. In the Corliss invention the valve does not leave its seat, it slides back and forth. As a poppet valve is dropped to its seat, it is necessary to bring the valve to rest in an extremely short distance in order to prevent slamming and destruction. Sickles used for that purpose a water dashpot. With the Corliss valve it matters little when the motion of the valve is arrested; it can pass over the ports and close them at full speed, and whether it stops a little sooner or a little later is of no consequence. Corliss brought his valves to rest by means of weights and cushioned the weight simply by an air cushion. Theoretically, the Sickles invention was all right, but the Corliss invention was the most practical one. A prominent engine designer, a man of the theory, connected with the Allis-Chalmers Co., once relieved his mind as follows: "Damn practice, it always interferes with theory." The theory that Corliss possessed never interfered with practice. Corliss' head was not filled with theory, he was a practical fellow, without college or technical training. He did not know anything about algebra, but he knew how to build useful engines right and left and put them on the market. Frederick E. Sickles was a marine engineer who fought for his theory, but a theory that interfered with practice. As stated before, Corliss got his first patent in 1849 for a term of 14 years. In 1851 and again 1859 the patent was renewed and at that time divided into six patents, each one covering a certain part of the Corliss engine. One patent was for the wristplate, one for the liberation of the valves, one for the air cushion, one for the positive closing of the valves, one for the claws and one for the combination of the governor with the cutoff.

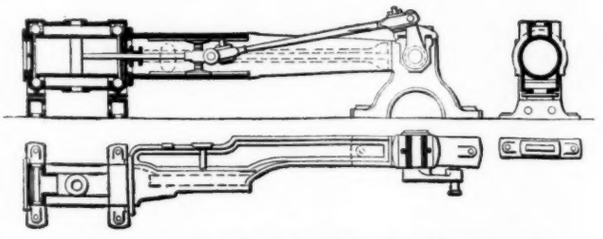


FIG. 12. THE CORLISS GIRDER-FRAME ENGINE

There was no patent on the four-valve cylinder, and the credit of originating it has been claimed by others. William Wright, at one time foreman of the Corliss shops, was one who claimed it.

Engine Frames Designed by Corliss

Corliss not only developed the valve gear to a high degree of perfection, but all other parts of his engine also. Under the hands of this genius the whole engine

soon had a different appearance in every detail. The old-style engine bed, which looked like a coffin with two low sides and a crosspiece at each end, he discarded altogether. Figs. 9, 10, 11 and 12 show the gradual development of the final standard, the familiar girder frame. First came the box-type frame, which had the shape of the letter U. The front end served as a bearing for the crankshaft, and the rear end carried the cylinder on one side and the valve gear on the other. The guides were bolted to the side of the frame. The open top of the frame was closed with a polished mahogany cover. It is said that engineers found it convenient to lay tools and things inside of the U frame, and when more than full they had some bother to make the lid fit nicely. Corliss later changed the design, turned it upside down, right. One of the first, a 180-hp. unit, was installed in a flour mill and the mill people agreed to give Corliss the savings over the old engines for a period of five years. Corliss realized from this outfit the sum of $19,734.22. A few more such contracts put him in shape to pay for his $100,000 lawsuits.

After the first success in economy, Corliss made the most daring guarantees for his engines the world had ever heard of. In 1852 he got a contract for an engine to drive a rail mill that he guaranteed would develop one-third more power than the old engine and at the same time reduce the daily coal bill from five tons to two tons, and in case of failure he would pay a penalty of not less than $1 for each pound of coal used in excess of his guarantee. A still bolder guaran-

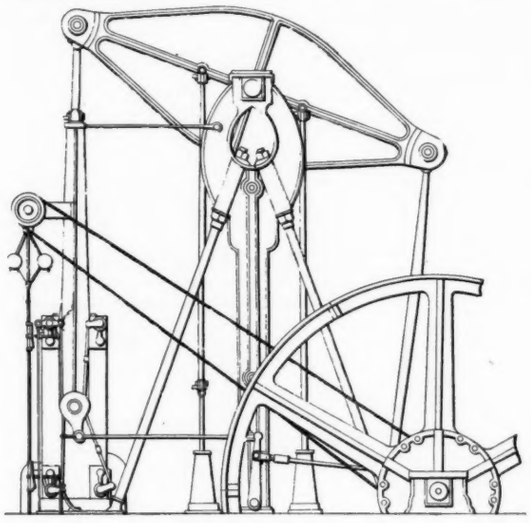


FIG. 13

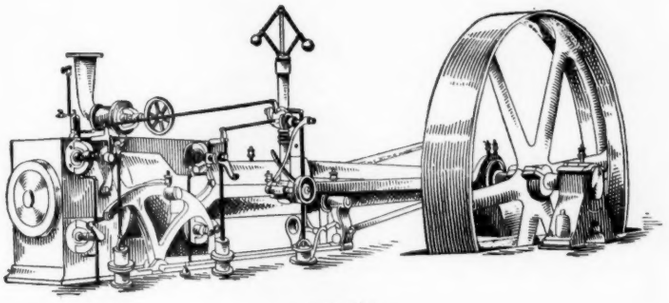


FIG. 15

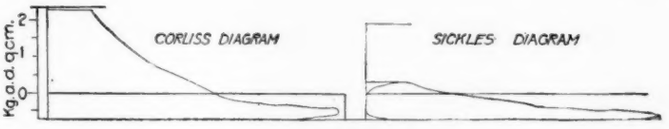


FIG. 14

FIGS. 13 TO 15. EARLY AND LATER DESIGNS CONTRASTED

Fig. 13—One Corliss engine that supplanted a Sickles. Fig. 14—Shows an indicator diagram from each. Fig. 15—A typical Corliss of late design

and the worry of the engineer in fitting the lid properly was done away with. Then came the girder, a frame extending between the main bearing and the cylinder, and carrying also the crosshead guide; the whole engine standing on the foundation instead of lying down, showing good proportions and graceful lines. Fig. 13 shows a 32 x 84-in. engine installed in 1853, in a cotton mill, to replace a Sickles poppet-valve engine that had been in operation only 2½ years, and guaranteed to effect a saving of 50 per cent. at the coal pile. Fig. 14 shows indicator diagrams from the competing engines and why Corliss effected the big saving. If Sickles had studied the poppet engines abroad and improved on his design, he could have made the road for Corliss far more difficult. Fig. 15 shows a highly developed horizontal engine.

Corliss met with considerable difficulty in finding customers for his first engines; people were prejudiced against the new machine. The valve gear was considered too complicated, and fear was expressed that it would not stand up under the working strain. Nobody believed in the advantages claimed by Corliss. To overcome this terrible resistance and secure orders for his shop, Corliss introduced his engines by giving them away and receiving as payment therefor only the savings effected over and above the old-time machines. This plan of introducing his engine proved to be all tee was made in another case. He furnished a 200-hp. engine for a certain concern for the modest price of $7100 (almost seven times as much as what an engine of that size could have been purchased for a few years ago) to replace an old one of the same size which was using over nine tons of coal per day. Corliss guaranteed that his engine would not use more than four tons, and he would pay $5000 for every ton of coal used in excess of his guarantee. Those daring guarantees soon established such a reputation for the engine that almost any price that Corliss asked would be paid. These fabulous guarantees would look suspicious to engineers of today, but notice that Corliss never guaranteed that his engine would save a certain amount in steam consumption per indicated horsepower-hour. He guaranteed the saving at the coal pile only. He was wise in doing so, for if based on the steam consumption his guarantee would never have been so big and blustering. Corliss was not only a remarkably great engineer, but also a remarkably shrewd business man. The way he introduced his engine and the manner he advertised are proof of that. He had a keen eye for the things going on in the boiler room. He knew then, as we know now, that when a boiler is forced by unskilled hands, much fuel is wasted, that when a boiler is fired moderately the chances for obtaining drier and consequently less costly steam are far better; therefore he knew that when his

engine would be hitched to a battery of overworked boilers those boilers would be greatly relieved and a great saving effected right there in the boiler room.

It is a recorded fact that Corliss believed in ample boiler capacity, believed in "lots of boiler capacity." Boilers furnishing steam to his engines generally had a snap. In those plants installed and guaranteed by Corliss only from one-half to one-third as much steam per square foot of heating surface was generated as in boilers of other plants. He also believed in superheated steam, and all boilers furnished by him were arranged for that purpose. Another condition that existed in those days when Corliss made his bewildering guarantees was that the old engines were too small to handle the load economically, a condition naturally in favor of he saw to it that his engine rapidly became the standard mill engine. The first engines built by Corliss were of the walking-beam type, but he soon devoted himself to the development of the horizontal type and achieved a wonderful success. He also built a number of pumping engines; the first one was for the City of Providence, R. I. This machine had five horizontal steam cylinders and five horizontal double-acting pumps, evenly spaced around one central vertical shaft. There was no dead-center, no flywheel and no limit to the slow speed which the pump could run. It could run as slow as one revolution in five minutes. In 1857 Corliss built his first cross-compound engine with steam-jacketed cylinders.

In 1870 the Corliss patents became public property, and a number of firms throughout the land began to

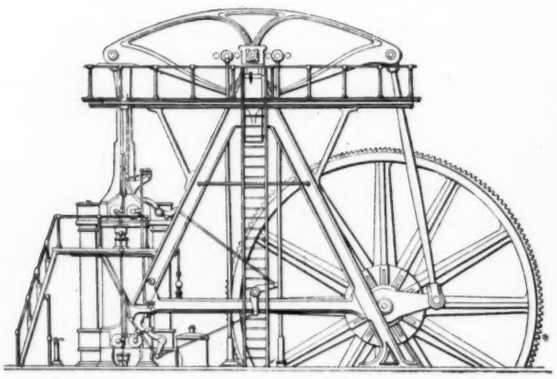


FIG. 16

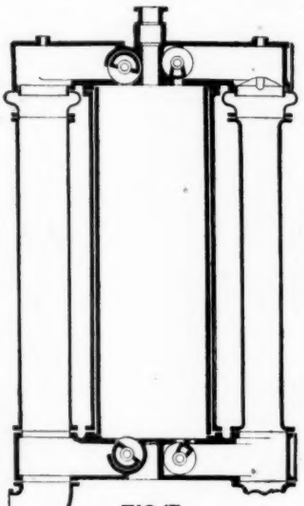
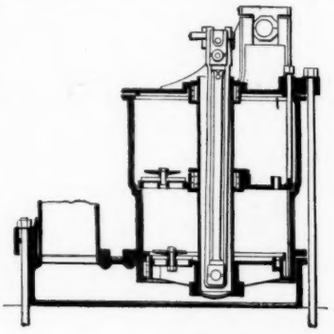


FIG. 17



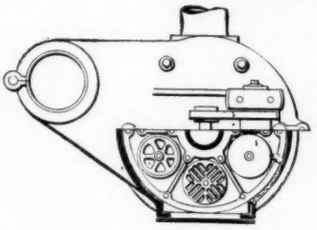


FIG. 19

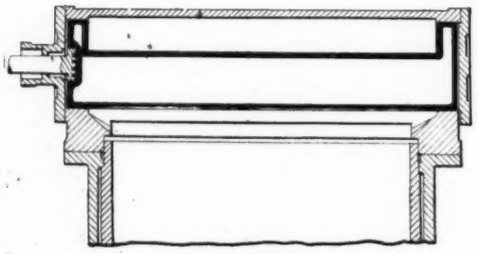


FIG. 18

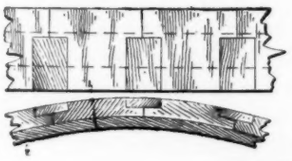


FIG. 20

FIGS. 16 TO 20. SECTIONAL VIEWS OF THE CENTENNIAL ENGINE, CYLINDER, VALVES AND AIR PUMPS
Fig. 16—General outline. Fig. 17—Cylinder, showing position of valves. Fig. 18—Design of valves. Fig. 19—Two views of condenser and air pump. Fig. 20—Wooden packing for air-pump plungers.

the new Corliss engine replacing such overloaded units. From this consideration we see that the enormous saving guaranteed and fulfilled by Corliss was not altogether due to the Corliss engine alone, but that a good portion of it must be credited to the changes in the boiler room and to the old engines being overloaded.

Corliss not only made unusual guarantees as to economy but also as to perfect regulation of speed, which merit was of almost as much value to a cotton mill as the saving of fuel. The spindles of a spinning machine revolve with great rapidity, and a variation of speed at the engine will be many times multiplied by the time the motion reaches the fast-running spindle. If the spindle is driven faster than intended, bad work is the result, if it is driven too slow, diminished production is the consequence. The old-fashioned engines were not very satisfactory in governing. The Corliss engine was superior, and Corliss was not slow in guaranteeing it, and build Corliss engines. A few shops had been licensed by Corliss, but comparatively few engines were built outside of his works. He charged a license fee not only to outside builders, but also to the firm in which he was a partner. The fee was a dollar and a half per square inch piston area of cylinders over 24 in. diameter, and two dollars per square inch area for cylinders under 24 in. To save the 50c. on each square inch, the first cylinders had large diameters and short strokes, but after the expiration of the patents a marked increase in the length of the stroke with a corresponding decrease in bore is noted.

Fig. 16 is a line drawing of the Centennial Engine of 1876, and Figs. 17, 18, 19 and 20 are sectional details. This is no doubt the most famous engine ever built and was considered when new the most magnificent piece of work in the art of steam engineering. It was enthusiastically praised by all who saw it, and the Euro-

pean engineers credited it an unsurpassed masterpiece of human possibility and the most excellent representative of American steam engineering. The engineering press has referred to this engine times innumerable. I shall, therefore, make mention of only such parts as will be of general interest.

The "Centennial" was a vertical twin engine of the walking-beam type. Each side could develop about 700 hp., at 36 r.p.m., but in Philadelphia it was not called upon to do more than 400 hp. altogether, and it was operated with a steam pressure of from 15 to 22 lb. per sq. in., although it was intended to use 45 lb. The whole engine weighed 607 tons, and it required a train of 35 cars to ship it. The walking beams, of elegant design, had the form of wings, were 27 ft. long and 9 ft. high in the center, and weighed 11 tons each. The flywheel was a gear-wheel, the largest ever made, almost 30 ft. in diameter. It had 216 teeth and weighed 56 tons. The connecting-rods were 25 ft. long, 10 in. thick in the center, and were forged out of 9500 old horseshoes. The cranks were made of solid bronze highly polished and weighed 5 tons each. The cylinders were 40 in. diameter and 10 ft. stroke, steam jacketed. The valves were in the heads and clearance space was reduced to a minimum. The valves were 12 in. diameter and 52 in. long, cored hollow and operated by T-head valve stems. The ends of the valves were cylindrical for a short distance to serve as guides. Port area was $\frac{1}{11}$ of the piston area for the steam valves and twice that amount for the exhaust valves. Each half of the engine had its own condenser and air pump, of the vertical type, 36 in. diameter and 24 in. stroke, operated from the walking beams. The packing was made of wood, as shown in Fig. 20, pieces being joined together in a peculiar manner to break the joints.

I had the good fortune to see this engine in operation one whole day in the Pullman works. It stood in a room 84 ft. square by 66 ft. high kept like a palace. The engine generally delivered 1400 or 1500 hp., but one time it was called upon to deliver 2500 hp. One man's time was continually occupied in keeping the engine oiled. To refill the oil cups on the four extreme pins of the walking beams, it was necessary to shut the engine down every six hours. The engineer stopped the engine at a certain position and the oiler refilled two cups, then he turned the engine half a turn, and the other two cups were filled. In the fall of 1910 this famous engine, after a continuous service of over 30 years, was shut down for the last time and forever.

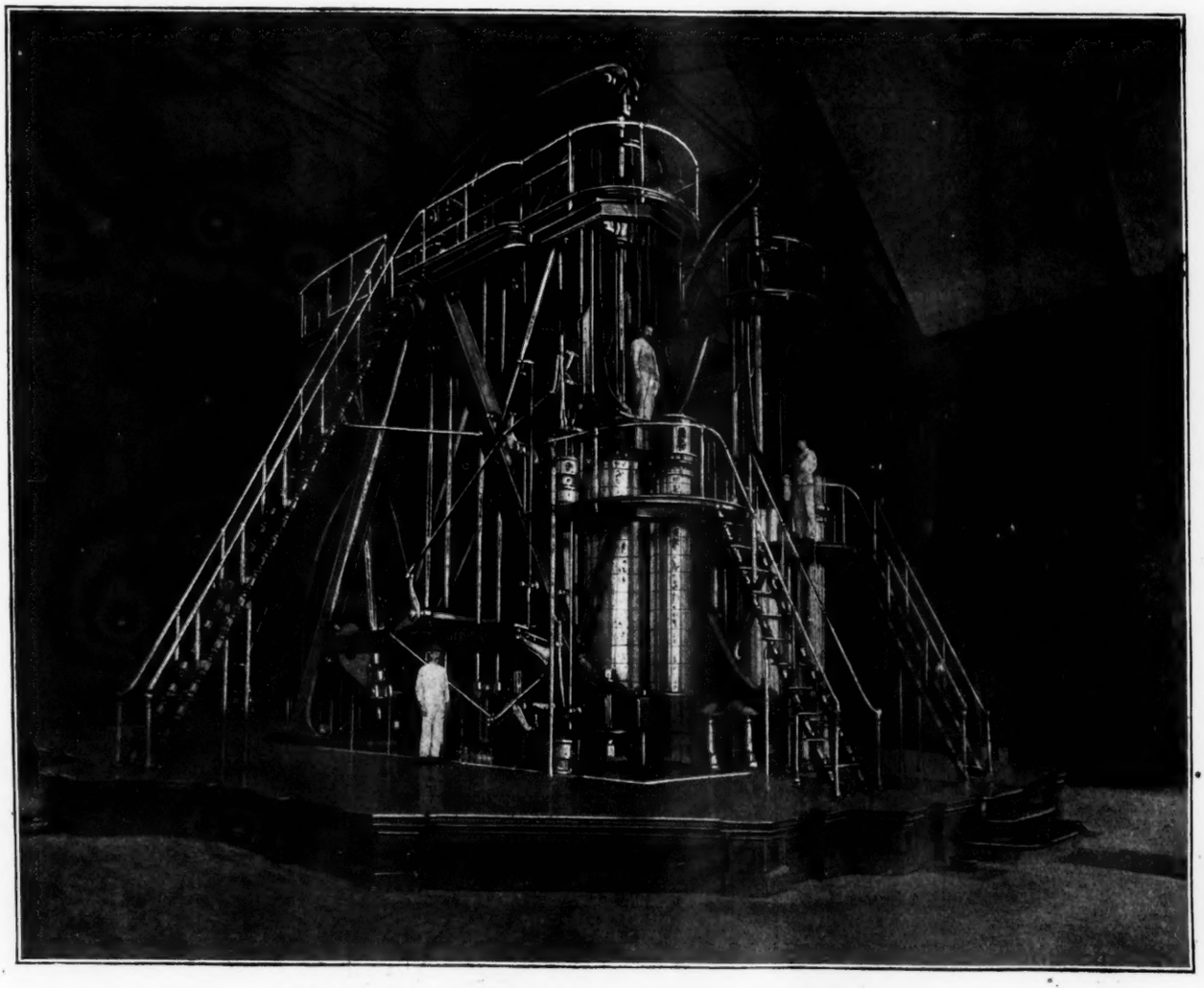


FIG. 21. THE CENTENNIAL ENGINE AT THE PULLMAN WORKS

Zone System for the Distribution of Bituminous Coal

By order of the Fuel Administration, the distribution of bituminous coal for the year beginning April 1, 1918, will be controlled by a zone system, which is intended to reduce the burden on the railroads, facilitate shipment of coal, and keep all the mines working at full capacity.

THE factor that loomed largest in the fuel crisis of last winter was the lack of adequate transportation facilities. Under the plan of distribution then followed, a consumer in any part of the country was free to order his coal supply from any producing district, regardless of the length of haul involved. As a consequence, it often happened that cars and locomotives were engaged in delivering coal to distant regions that could have been served far more quickly from fields near by.

Obviously, this complete freedom of choice as to the source of coal used led to cross-hauling in addition to the utilization of railroad equipment in unnecessarily long hauls, the result being a great waste of transportation power. To prevent this needless waste and make possible an increased production to meet the war demands, the United States Fuel Administration, in conjunction with the Director General of Railroads, has announced a zone system for the control of bituminous-coal distribution for the year beginning Apr. 1, 1918.

The zone system was adopted only after prolonged conferences with coal producers, jobbers and consumers, as well as with the traffic and operating officials of the railroads. Briefly explained, it divides the country into a number of zones, each of which must obtain its coal supply from mines that are relatively near, thus preventing abnormal and wasteful transportation movements, insuring more nearly equal distribution of cars to the mines and more steady employment of mine labor.

Of course, so radical a change in the methods of conducting the coal business will cause some inconvenience to producers and consumers, and will involve additional expense in some cases. For example, the producers of Pocahontas coal may no longer ship their output to Chicago and Western points by rail; as a result, they must find new markets in the East. Those plants in and around Chicago that have been burning West Virginia coal will be compelled to substitute Illinois coal, which can be obtained with less than half as long a haul. As the two fuels are of very different characters, changes in the boiler settings and methods of firing will have to be made, which will entail expense.

It is the hope of the Fuel Administration, however, that the consumer and the producer will bear these unavoidable inconveniences in the realization that the readjustment of the distribution of coal is for the welfare of the nation. In other words, they are appealed to on the grounds of patriotism.

There are exceptions to the conditions imposed by the zone system. Certain industries require coals of particular quality or characteristics, as, for example, by-product, gas, blacksmith and metallurgical coals. If a consumer needs coal of one of these kinds and is unable to obtain it from the producing districts that are permitted to ship into the zone in which he is located, permits will be issued to allow the special-purpose fuel to be brought in from other districts.

The zone system does not affect the following bituminous coal:

1. Coal for railroad fuel, for which special arrangements will be made by the Fuel Administrator and the Director General of Railroads.
2. Coal for movement on inland waterways, which is in no way restricted by the system.
3. Coal delivered to Canada, which is subject to regulations of the Fuel Administrator.

To enable the consumer of bituminous coal to determine the districts from which he may obtain his fuel and to show the producer the zones in which he may sell his output, the map has been prepared.

It will be seen that the entire territory of the United States has been divided into a large number of irregular zones or sections, colored differently so that they may readily be distinguished one from another, and each marked with a key number. Each of these separately numbered zones has certain definite boundary lines and is restricted to the use of coals from certain districts. The Key to Consuming Zones gives a complete list of all the zones shown on the map, states the districts from which they may obtain coal, and defines the boundaries of each zone.

If a consumer wishes to find out what coals are available for his use, he locates on the map the zone in which he lives and notes its number. Then, in the Key to Consuming Zones, under that zone number, he will find the list of producing districts from which he can obtain coal. In case there is any doubt as to the number of the zone in which he lives, reference to the boundaries given in the key will at once decide the point. Following this key is a list of the meanings of the abbreviations and terms used in the key.

The Key to Producing Districts is intended to show the producer the several zones in which he may market his product. He knows the district in which his mine is located, and on referring to this key he finds the numbers of the zones, as shown on the map, into which the output from his mine may be sent.

A wall map of large size, showing the same zoning in fuller detail, may be obtained from the Coal Zone Map Co., Glen Echo, Md.

KEY TO CONSUMING ZONES

ZONE NO. 1

RESTRICTED TO FOLLOWING COALS—North Dakota, South Dakota, docks.

BOUNDARIES—Northern and Western: Lake Superior and Canada; North Dakota state line and South Dakota state line to Ortonville, Minn. **Southern and Eastern:** From Ortonville via C. M. & St. P. Ry. through Granite Falls and Benton Junction to Minneapolis, thence via M. St. P. & S. S. M. Ry. through Chippewa Falls and Abbotsford to Amherst Junction, thence via G. B. & W. R. R. to Kewaunee, Wis.; western banks of Lakes Michigan and Huron.

ZONE NO. 2

RESTRICTED TO FOLLOWING COALS—Illinois (summer only), docks, North Dakota, South Dakota, Iowa (to points in Iowa only).

BOUNDARIES—Northern: From Kewaunee, Wis., via G. B. & W. R. R. to Amherst Junction, thence via M. St. P. & S. S. M. Ry. through Abbotsford and Chippewa Falls, Wis., to Minneapolis, Minn., thence via C. M. & St. P. Ry. through Benton Junction and Ortonville, Minn., to the Minnesota-South Dakota state line. **Western:** Minnesota-South Dakota state line. **Southern:** Commencing at South Dakota-Minnesota-Iowa state line east to the C. R. I. & P. Ry. line running through Gordonsville, Minn., and Northwood, Iowa, thence south via that line to Mason City, Iowa, thence east via C. M. & St. P. Ry. through McGregor, Iowa, Madison and Watertown to Milwaukee, Wis. **Eastern:** Lake Michigan from Kewaunee to Milwaukee, Wis.

ZONE NO. 3

RESTRICTED TO FOLLOWING COALS
—Illinois, Kentucky (Western), Indiana, docks.

BOUNDARIES—Northern and Western: From Milwaukee, Wis., via C. M. & St. P. Ry. to Waukesha, thence via M. St. P. & S. S. M. Ry. to Illinois-Wisconsin state line. **Eastern and Southern:** From Milwaukee, Wis., via Lake Michigan (west bank) to Illinois-Wisconsin state line, thence via that line to M. St. P. & S. S. M. Ry.

ZONE NO. 4

RESTRICTED TO FOLLOWING COALS
—Illinois, Kentucky (Western), docks.

BOUNDARIES—Northern: Via C. M. & St. P. Ry. from Milwaukee, Wis., through Watertown to Madison, Wis. **Southern:** Via C. M. & St. P. Ry. from Milwaukee, Wis., through Milton Junction to Madison, Wis.

ZONE NO. 4A

RESTRICTED TO FOLLOWING COALS
—Illinois, docks.

BOUNDARIES—Northern and Western: From Milwaukee, Wis., via C. M. & St. P. Ry. through Milton Junction to Madison, Wis., thence via I. C. R. R. to Dixon, Ill. **Eastern and Southern:** From Milwaukee, Wis., via C. M. & St. P. Ry. through Elkhorn to Beloit, Wis., thence via C. & N. W. Ry. through Belvidere and Sycamore to Dixon, Ill.

ZONE NO. 5

RESTRICTED TO FOLLOWING COALS
—Iowa, Kansas, Illinois, Missouri, Oklahoma, Arkansas.

BOUNDARIES—Northern and Eastern: From Sioux City, Iowa, via C. M. & St. P. Ry. through Rock Valley and Spencer to Nora Junction, thence via C. R. I. & P. Ry. to Cedar Rapids, thence via C. M. & St. P. Ry. through Sigourney to Ottumwa, thence via C. R. I. & P. Ry. to Keokuk, Iowa, thence via Mississippi River to Missouri-Arkansas state line. **Western and Southern:** From Sioux City, Iowa, via C. M. & St. P. Ry. through Manilla and Adel to Des Moines, Iowa, thence via C. B. & Q. R. R. to Albia, thence via W. Ry. to Moravia, Iowa, thence via C. M. & St. P. Ry. to Chillicothe, Mo., thence via W. Ry. to Moberly, thence via M. K. & T. Ry. through New Franklin to North Jefferson City, thence via western boundary of Cole, Miller and Pulaski Counties to St. L. S. F. Ry., thence via St. L. S. F. Ry. through Springfield and Neosho to Missouri-Oklahoma state line, thence south to Arkansas-Missouri-Oklahoma state line, thence east via Arkansas-Missouri state line to the Mississippi River.

ZONE NO. 6

RESTRICTED TO FOLLOWING COALS
—Illinois, Kentucky (Western).

BOUNDARIES—Northern and Western: —From Arthur, Ill., via P. C. C. & St. L. R. R. to Decatur, Ill., thence via I. C. R. R. through Centralia to Cairo, Ill., thence via Mississippi River to Memphis, Tenn. **Eastern and Southern:** From Arthur, Ill., via C. & E. I. R. R. through Marion to Joppa, Ill., thence via Ohio River to Cairo, Ill., and thence via I. C. R. R. through Clinton and Fulton, Ky., and Dyersburg, Tenn., to Memphis, Tenn.

ZONE NO. 6A

RESTRICTED TO FOLLOWING COALS
—Illinois, Kentucky (Western), docks.

BOUNDARIES—Northern: From Madison, Wis., to Woodman, Wis., via C. M. & St. P. Ry. **Southern:** From Madison, Wis., to Woodman, Wis., via C. & N. W. Ry.

ZONE NO. 7

RESTRICTED TO FOLLOWING COALS
—Illinois, Iowa (to points in Iowa only).

BOUNDARIES—Northern and Eastern: From Nora Junction, Iowa, via C. M. & St. P. Ry. to Woodman, Wis., thence via C. & N. W. Ry. to Madison, Wis., thence via I. C. R. R. to Freeport, Ill., thence via I. C. R. R. to Dixon, Ill., thence via C. & N. W. Ry. through Nelson to Peoria, thence via P. C. C. & St. L. R. R. to Decatur, thence via I. C. R. R. through Centralia to Cairo, Ill. **Southwestern:** From Nora Junction, Iowa, via C. R. I. & P. Ry. to Cedar Rapids, thence via C. M. & St. P. Ry. to Ottumwa, thence via C. R. I. & P. Ry. to Keokuk, Iowa, thence east of the Mississippi River to Cairo, Ill.

ZONE NO. 8

RESTRICTED TO FOLLOWING COALS
—Illinois, Indiana.

BOUNDARIES—Northern and Eastern: From Dixon, Ill., via I. C. R. R. to Decatur, Ill. **Western and Southern:** From Dixon, Ill., via C. & N. W. Ry. through Nelson to Peoria, Ill., thence via P. C. C. & St. L. R. R. to Decatur, Ill.

ZONE NO. 9

RESTRICTED TO FOLLOWING COALS
—Illinois, Indiana, Kentucky (Western).

BOUNDARIES—Northern and Western: From Waukesha, Wis., via C. M. & St. P. Ry. to Beloit, Wis., thence via C. & N. W. Ry. through Belvidere, Sycamore, DeKalb, to Dixon, Ill., thence via I. C. R. R. to Decatur, Ill., thence via P. C. C. & St. L. R. R. to Arthur, thence via C. & E. I. R. R. through Mt. Vernon to Joppa, Ill. **Eastern and Southern:** From Waukesha, Wis., via M. St. P. & S. S. M. Ry. to Wisconsin-Illinois state line, thence via this line to Lake Michigan, thence via Lake Michigan to Michigan City, Ind., thence via C. I. & L. Ry. to San Pierre, thence via N. Y. C. R.R. to Wheatfield, thence via C. & E. I. R. R. through Brazil and Otter Creek Junction through Vincennes to Evansville, Ind., thence both sides of the Ohio River, Evansville, Ind., to Joppa, Ill.

ZONE NO. 10

RESTRICTED TO FOLLOWING COALS
—Indiana, Illinois (Danville district on Wabash Ry. only), Kentucky (Western, to Jeffersonville and New Albany only).

BOUNDARIES—Northern and Western: From San Pierre, Ind., via N. Y. C. R.R. to Wheatfield, thence via C. & E. I. R.R. through Brazil, Otter Creek Junction and Vincennes to Evansville, Ind. **Eastern and Southern:** From San Pierre, Ind., via C. I. & L. Ry. to New Albany, Ind., thence along northern bank of Ohio River to Evansville, Ind.

ZONE NO. 11

RESTRICTED TO FOLLOWING COALS
—Virginia (L. & N. R.R.), Tennessee (M. R.R.), West Virginia (Southern), Illinois, Indiana, Kentucky (Eastern and Western).

BOUNDARIES—Southeastern: From San Pierre, Ind., via N. Y. C. R.R. north to South Bend, Ind., thence via M. C. R.R. to Michigan-Indiana state line. **Western and Northern:** From San Pierre, Ind., north to Michigan City, thence along Lake Michigan and Indiana-Michigan state line to M. C. R. R. from South Bend, Ind., to Niles, Mich.

ZONE NO. 12

RESTRICTED TO FOLLOWING COALS
—Indiana, Illinois (Danville district on Wabash Ry. only).

BOUNDARIES — Northeastern — From Monon, Ind., via C. I. & L. Ry. to Indianapolis, Ind., thence via C. C. C. & St. L. Ry. through Greensburg to North Vernon, Ind., thence via P. C. C. & St. L. R.R. to Madison, Ind. **Southwestern:** From Monon, Ind., via C. I. & L. Ry. to Louisville, Ky., thence via Ohio River to Madison, Ind.

ZONE NO. 13

RESTRICTED TO FOLLOWING COALS
—Kentucky (Western).

BOUNDARIES—Northern and Eastern: From Cairo, Ill., along Ohio River (north bank) to Louisville, Ky., thence south via L. & N. R.R. from Louisville through Bowling Green, Ky., including Glasgow and Scottsville branches, to Kentucky-Tennessee state line. **Western and Southern:** From Cairo, Ill., via I. C. R.R. through Fulton, Ky., to Kentucky-Tennessee state line, thence east via state line to L. & N. R.R. running from Franklin, Ky., to Mitchellville, Tenn.

ZONE NO. 14

RESTRICTED TO FOLLOWING COALS
—Indiana, Kentucky (Eastern), West Virginia (Northern and Southern), Virginia (L. & N.), Tennessee (M. R.R.), Michigan, Ohio (on G. R. & I. Ry. only).

BOUNDARIES—Northern and Western: From Mackinaw City, east bank of Lake Michigan, to Benton Harbor, Mich., thence via C. C. C. & St. L. Ry. to Niles, thence via M. C. R.R. to Michigan-Indiana state line. **Eastern and Southern:** From Mackinaw City via G. R. & I. Ry. and branches to Michigan-Indiana state line, thence west via state line to M. C. R.R. running from Niles to South Bend, Ind.

ZONE NO. 15

RESTRICTED TO FOLLOWING COALS
—Illinois, Indiana, Kentucky (Eastern and Western), West Virginia (Northern and Southern), Virginia (L. & N.), Tennessee (M. R.R.), Michigan.

BOUNDARIES—Northern and Western: From Benton Harbor, Mich., via Lake Michigan to Indiana-Michigan state line. **Eastern and Southern:** From Benton Harbor, Mich. via C. C. C. & St. L. Ry. to Niles, thence via M. C. R.R. to Indiana-Michigan state line, thence west via state line to Lake Michigan.

ZONE NO. 16

RESTRICTED TO FOLLOWING COALS
—Indiana, Illinois (Danville district on Wabash Ry. only), Kentucky (Eastern), West Virginia (Southern).

BOUNDARIES—Northern: Michigan-Indiana state line from G. R. & I. Ry. west to M. C. R. R. running from Niles, Mich. to South Bend, Ind. **Western:** Via N. Y. C. R. R. South Bend to San Pierre, thence via C. I. & L. Ry. through Monon to Indianapolis, thence via C. C. C. & St. L. Ry., Indianapolis to Greensburg, Ind. **Eastern:** G. R. & I. Ry. from Michigan state line south to Richmond, Ind., thence via P. C. C. & St. L. R. R. to Greensburg, Ind.

ZONE NO. 17

RESTRICTED TO FOLLOWING COALS
—Virginia (L. & N. R.R.), Kentucky (Eastern), Tennessee (M. R.R.), West Virginia (Southern).

BOUNDARIES—From Cincinnati north via P. C. C. & St. L. Ry. to Richmond, Ind., thence west to Rushville, Ind., thence south via C. C. C. & St. L. R.R. through Greensburg, thence east to Cincinnati, O.

ZONE NO. 18

RESTRICTED TO FOLLOWING COALS
—Virginia (L. & N. R.R.), Kentucky (Southern), Tennessee (M. R.R.).

BOUNDARIES—Northern and Western: Cincinnati, Ohio, via C. C. C. & St. L. Ry. through Greensburg, to North Vernon, Ind., thence via P. C. C. & St. L. R.R. to Madison, Ind. **Eastern and Southern:** North bank Ohio River, Cincinnati, Ohio, to Madison, Ind.

ZONE NO. 19

RESTRICTED TO FOLLOWING COALS
—Kentucky (Eastern), Tennessee (M. R.R.), West Virginia (Southern, also Eastern, to points on C. & O. Ry. from Catlettsburg, Ky., to Cincinnati, Ohio).

BOUNDARIES—Northern and Eastern. From Louisville, Ky., via Ohio River and Big Sandy River to Kentucky-Virginia-West Virginia state line. **Western and Southern:** From Louisville, Ky., to Lebanon Junction to Bowling Green, Ky., to Mitchellville, Tenn., including Glasgow and Scottsville (Kentucky) branches, thence via Kentucky-Tennessee state line and Kentucky-Virginia state line via Tug River to Big Sandy River.

ZONE NO. 20

RESTRICTED TO FOLLOWING COALS
—Virginia (L. & N. R. R.), Kentucky, (Eastern), Tennessee (M. R.R.), West Virginia (Northern and Southern), Indiana, Illinois (Danville district on Wabash Ry. to points in Indiana only), Ohio, Michigan.

BOUNDARIES—Southern and Eastern: From Richmond, Ind., east via P. C. C. & St. L. R. R. to Ohio state line, thence north via state line to Michigan state line, thence via N. Y. C. R. R. to Jackson, Mich., thence via M. C. R.R. to Lansing, thence via P. M. Ry. through Ionia to Howard City, Mich. **Western:** From Howard City, Mich., via G. R. & I. Ry. through Fort Wayne to Richmond, Ind.

ZONE NO. 21

RESTRICTED TO FOLLOWING COALS
—Virginia (L. & N. R.R.), Kentucky (Eastern), Tennessee (M. R.R.), West Virginia (Northern and Southern), Ohio, Michigan.

BOUNDARIES—Northern and Eastern: From Mackinaw City, Mich., along the eastern boundary of Michigan (lower peninsula) and Ohio to Toledo, Ohio, thence via C. C. C. & St. L. Ry. through Bellefontaine to Dayton, Ohio. **Western and Southern:** From Mackinaw City, Mich., via G. R. & I. Ry. to Howard City, thence via P. M. Ry. through Ionia to Lansing, Mich., thence via M. C. R.R. to Jackson, thence via N. Y. C. R.R. to Indiana-Michigan-Ohio state line, thence south along state line and P. C. C. & St. L. R. R. running from Richmond, Ind., to Dayton, Ohio.

ZONE NO. 22

RESTRICTED TO FOLLOWING COALS
—Virginia (L. & N. R.R.), Kentucky, (East-

ern), Tennessee (M. R.R.), West Virginia (Southern), Ohio.

BOUNDARIES—From Cincinnati, Ohio, north via C. C. C. & St. L. Ry. to Dayton, Ohio, thence via P. C. C. & St. L. R.R. west to Richmond, Ind., thence southeast via P. C. C. & St. L. R.R. to Cincinnati, Ohio.

ZONE NO. 23

RESTRICTED TO FOLLOWING COALS—Kentucky (Northeastern). West Virginia (Northern and Southern, also Eastern, along main lines of C. & O. Ry. and N. & W. Ry. to Columbus and Cincinnati, Ohio) Ohio.

BOUNDARIES—Northern and Eastern: From Toledo, Ohio, via south bank of Lake Erie to Sandusky, Ohio, thence via P. C. C. & St. L. R.R. through Columbus, thence via N. & W. Ry. through Circleville to Chillicothe. **Western and Southern:** From Toledo, Ohio, via C. C. C. & St. L. Ry. through Springfield to Dayton, Ohio, thence via B. & O. R. R. through Washington C. H. to Chillicothe, Ohio.

ZONE NO. 24

RESTRICTED TO FOLLOWING COALS—Kentucky (Northeastern), West Virginia (Southern, also Eastern, along main lines of C. & O. Ry. and N. & W. Ry. to Columbus and Cincinnati, Ohio), Ohio.

BOUNDARIES—Northern and Eastern: From Dayton, Ohio, via B. & O. R.R. through Washington C. H. to Chillicothe, thence via N. & W. Ry. to Waverly, thence via C. & O. Northern Ry. to Portsmouth. **Western and Southern:** From Dayton, Ohio, via C. C. C. & St. L. Ry. to Cincinnati, Ohio, thence via north bank of Ohio River to Porstmouth, Ohio.

ZONE NO. 25

RESTRICTED TO FOLLOWING COALS—West Virginia (Northern, also Eastern, along main lines of C. & O. Ry. and N. & W. Ry. to Columbus and Cincinnati, Ohio), Ohio.

BOUNDARIES—Northern and Eastern: From Bucyrus, Ohio, via T. & O. C. Ry. to Thurston, Ohio, thence via Z. & W. Ry. through Fultonham to Zanesville, thence via Z. & W. Ry., K. & M. Ry. to Athens. **Western and Southern:** From Bucyrus, Ohio, via P. C. C. & St. L. R.R. to Marion, Ohio, thence via H. V. Ry. to Columbus, thence via N. & W. Ry. to Chillicothe, thence via B. & O. Ry. to Athens, Ohio.

ZONE NO. 26

RESTRICTED TO FOLLOWING COALS—Ohio.

BOUNDARIES—Northern and Eastern: From Sandusky, Ohio, via south bank of Lake Erie to Lorain, thence via W. & L. E. Ry. through Wellington to Pittsburgh Junction, thence via P. & W. V. Ry. through Mingo Junction to Ohio River. **Southern and Western:** From Sandusky, Ohio, via P. C. C. & St. L. R.R. to Bucyrus, Ohio, thence via T. & O. C. Ry. to Thurston, thence through Zanesville to Athens, thence via K. & M. Ry. through Athens to Middleport, thence via Ohio River (north bank) to P. & W. V. Ry. opposite Mingo Junction.

ZONE NO. 27

RESTRICTED TO FOLLOWING COALS—Pennsylvania, Ohio.

BOUNDARIES—Northern and Western: Along south bank Lake Erie from Conneaut, Ohio, to Lorain, Ohio, thence via W. & L. E. Ry. through Wellington to Pittsburgh Junction, thence via P. & W. V. Ry. through Mingo Junction to Ohio River. **Eastern and Southern:** From Conneaut, Ohio, via Pennsylvania-Ohio state line to East Liverpool, Ohio, thence via Ohio River to P. & W. V. Ry. at a point opposite Mingo Junction.

ZONE NO. 28

RESTRICTED TO FOLLOWING COALS—No change contemplated in this plan, except that low-volatile coal in the Pocahontas, Tug River and New River districts on the N. & W. R. R. and the C. & O. Ry. and the Virginian Ry., and Clinch Valley districts in Tazewell and eastern Russell Counties along the N. & W. R. R., also high-volatile east of Charleston, W. Va., on C. & O. Ry. and east of Iaeger, W. Va., on N. & W. R. R. will be restricted to the District of Columbia, (except C. & O. Ry.) Virginia, (including tidewater terminals) also points in West Virginia on the direct line of the C. & O. Ry. and N. & W. R. R. east and west bound and Virginia Ry. east bound.

BOUNDARIES—All territory east and northeast of Ohio, Kentucky and Virginia, including New England.

ZONE NO. 29

RESTRICTED TO FOLLOWING COALS—Ohio, West Virginia (Northern, also Eastern, to points on the direct lines of the C. & O. Ry. and N. & W. Ry.).

BOUNDARIES—Northern and Eastern: From Chillicothe, Ohio, via B. & O. R.R. to Athens, thence via K. & M. Ry. to Middleport, thence via Ohio River (north bank) to Ironton, Ohio. **Western and Southern:** From Chillicothe, Ohio, via N. & W. Ry. to Waverly, thence via C. & O. N. Ry. to Portsmouth, thence via Ohio River (north bank) to Ironton, Ohio.

ZONE NO. 30

RESTRICTED TO FOLLOWING COALS—No change.

BOUNDARIES—All territory west of the following state lines: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma and Texas.

ZONE NO. 31

RESTRICTED TO FOLLOWING COALS—North Dakota, Wyoming, Montana and other fields east of the Rocky Mountains, docks.

BOUNDARIES—All territory in North Dakota west of the Missouri River.

ZONE NO. 32

RESTRICTED TO FOLLOWING COALS—North Dakota, South Dakota, Wyoming, Montana, docks.

BOUNDARIES—Northern, Western and Southern: North boundary of North Dakota to Montana, thence south to and via Missouri River to Mobridge, S. D., thence via C. M. & St. P. Ry. through Aberdeen to Bigstone City, S. D. **Eastern:** East boundary of North Dakota, thence via Minnesota-South Dakota state line to Bigstone City, S. D.

ZONE NO. 33

RESTRICTED TO FOLLOWING COALS—South Dakota, Wyoming, Montana and other fields east of the Rocky Mountains, North Dakota, docks.

BOUNDARIES—Northern and Eastern: From Montana-North Dakota-South Dakota state line to the Missouri River, thence via Missouri River to South Dakota-Nebraska state line. **Western and Southern:** Western and southern state boundary of South Dakota.

ZONE NO. 34

RESTRICTED TO FOLLOWING COALS—North Dakota, South Dakota, Wyoming, Montana, Illinois (summer), docks.

BOUNDARIES — Southwestern: From Mobridge, S. D., via Missouri River to Sioux City, Ia. **Northern and Eastern:** From Mobridge, S. D., via C. M. & St. P. Ry. through Aberdeen, S. D., to Bigstone City, S. D., thence via Minnesota-South Dakota state line and Iowa-South Dakota state line to Sioux City, Ia.

ZONE NO. 35

RESTRICTED TO FOLLOWING COALS—Iowa, Kansas, Missouri, Arkansas, Oklahoma, Colorado and other fields east of the Rocky Mountains, Wyoming.

BOUNDARIES—Entire state of Nebraska.

ZONE NO. 36

RESTRICTED TO FOLLOWING COALS—Kansas, Missouri, Iowa, Arkansas, Oklahoma, Colorado (Southern).

BOUNDARIES—Entire state of Kansas.

ZONE NO. 37

RESTRICTED TO FOLLOWING COALS—Oklahoma, Missouri, Arkansas, Kansas, Colorado, New Mexico, Texas.

BOUNDARIES—Entire state of Oklahoma.

ZONE NO. 38

RESTRICTED TO FOLLOWING COALS—New Mexico, Colorado, Texas.

BOUNDARIES—All Texas territory west of Pecos River.

ZONE NO. 39

RESTRICTED TO FOLLOWING COALS—Colorado, New Mexico, Arkansas, Oklahoma, Texas.

BOUNDARIES—Northern and Eastern: From New Mexico-Oklahoma-Texas state line east along northern border of Texas to Arkansas-Louisiana-Texas state line, thence south to Logansport, La., thence via H. E. & W. T. Ry. to Houston, via G. H. & H. R.R. to Galveston, thence Gulf of Mexico to Rio Grande River. **Southwestern:** From New Mexico-Oklahoma-Texas state line to Pecos River, thence via Pecos River to Rio Grande River thence via Rio Grande River to the Gulf of Mexico.

ZONE NO. 40

RESTRICTED TO FOLLOWING COALS—Kentucky (Western), Alabama, Texas.

BOUNDARIES—Northwestern: From Logansport, La., via H E. & W. T. Ry. to Houston, Texas, thence via G. H. & H. R. R. to Galveston. **Eastern and Southern:** From Logansport, La., along Louisiana-Texas state line to the Gulf of Mexico.

ZONE NO. 41

RESTPICTED TO FOLLOWING COALS—Arkansas, Illinois (summer), Iowa, Kansas, Missouri, Oklahoma, docks.

BOUNDARIES—Northern and Western: From Minnesota-Iowa state line directly south of Gordonsville, Minn., to Iowa-Minnesota-South Dakota state line, thence directly south along Iowa-South Dakota state line to Rock Valley, Ia. **Eastern and Southern:** From Iowa-Minnesota state line directly south of Gordonsville, Minn., via C. R. I. & P. Ry. to Mason City, Ia., thence via C. M. & St. P. Ry. to Rock Valley, Ia.

ZONE NO. 42

RESTRICTED TO FOLLOWING COALS—Arkansas, Iowa, Kansas, Missouri, Oklahoma.

BOUNDARIES—Northeast: From Sioux City, Ia., via C. M. & St. P. Ry. through Manilla and Adel to Des Moines, thence via C. B. & Q. R. R. through Chariton to Albia, thence via W. Ry. to Moravia, Ia., thence via C. M. & St. P. Ry. through Seymour to Missouri-Iowa state line. **Western and Southern:** From Sioux City, Ia., via Missouri River (east bank) to Iowa-Missouri state line, thence via Missouri state line, north boundary, to C. M. & St. P. Ry. line running south from Seymour, Ia.

ZONE NO. 43

RESTRICTED TO FOLLOWING COALS—Iowa, Arkansas, Kansas, Missouri, Oklahoma.

BOUNDARIES—Northeastern and Southern: Iowa-Missouri state line from Missouri River to C. M. & St. P. Ry. running south from Moravia, Ia., through Chillicothe, Mo., thence via W. Ry. through Huntsville to Moberly, thence via M. K. & T. Ry. through New Franklin to North Jefferson City, thence via western boundary of Cole, Miller and Pulaski Counties, Mo., to St. L. S. F. Ry. thence via St. L. S. F. Ry. through Lebanon, Springfield, to Missouri-Oklahoma state line. **Western:** Western boundary of Missouri.

ZONE NO. 44

RESTRICTED TO FOLLOWING COALS—Arkansas, Illinois, Kansas, Missouri, Oklahoma, Texas.

BOUNDARIES—Northern and Eastern: From Arkansas-Missouri-Oklahoma state line east to Mississippi River, thence via Mississippi River (west bank) to Memphis, Tenn. **Western and Southern:** From Arkansas-Missouri-Oklahoma state line south to C. R. I. & P. Ry. running from Howe, Okla., through Mansfield, Danville and Little Rock, Ark., to Memphis, Tenn.

ZONE NO. 45

RESTRICTED TO FOLLOWING COALS—Alabama, Arkansas, Illinois (only on lines of St. L. S. W. Ry. and St. L. I. M. & S. Ry), Kansas, Missouri, Oklahoma, Kentucky (Western), Texas.

BOUNDARIES—Northern and Eastern: From Arkansas-Oklahoma state line via C. R. I. & P. Ry. running from Howe, Okla., through Mansfield, Danville and Little Rock, Ark., to Memphis, Tenn., thence via Mississippi River (west bank) to Arkansas-Louisiana state line. **Western and Southern:** South along Arkansas-Oklahoma state line from C. R. I. & P. Ry. Howe, Okla., to Mansfield, Ark., to Arkansas-Louisiana-Texas state line, thence east along Arkansas-Louisiana state line to the Mississippi River.

ZONE NO. 46

RESTRICTED TO FOLLOWING COALS—Alabama, Arkansas, Illinois (only on lines of St. L. S. W. Ry. and St. L. I. M. & S. Ry.), Kentucky (Western), Texas.

BOUNDARIES—Northern and Eastern: From Arkansas-Louisiana-Texas state line east to the Mississippi River, thence along Mississippi River (west bank) to the Gulf of Mexico. **Western and Southern:** Louisiana-Texas state line to the Gulf of Mexico, thence to Mississippi River.

ZONE NO. 47

RESTRICTED TO FOLLOWING COALS—Kentucky (Western).

BOUNDARIES—Northern and Eastern: From Kentucky-Tennessee state line south of Fulton, Ky., east to L. & N. R. R. passing south through Mitchellville, Tenn., through Nashville and Columbia to Iron City, Tenn., including Scottsville and Hartsville, Ky., branches. **Western and Southern:** From Kentucky-Tennessee state line south of Fulton, Ky., via I. C. R. R. to Memphis, thence east via N. C. & St. L. Ry. to Perry-

ville, thence along Tennessee River (east bank) to Alabama-Mississippi-Tennessee state line, thence via Alabama-Tennessee state line to Iron City, Tenn.

ZONE NO. 48

RESTRICTED TO FOLLOWING COALS—Alabama.

BOUNDARIES—Northern and Eastern: From Memphis, Tenn., via N. C. & St. L. Ry. to Perryville, thence via Tennessee River (west bank) to Alabama-Mississippi-Tennessee state line. **Western and Southern:** From Memphis to Arkansas-Mississippi-Tennessee state line, thence east along Mississippi-Tennessee state line to the Tennessee River.

ZONE NO. 49

RESTRICTED TO FOLLOWING COALS—Alabama, Kentucky (Western).

BOUNDARIES—Northern and Eastern: Tennessee-Mississippi state line and Alabama-Mississippi state line. **Western and Southern:** East bank Mississippi River to the Gulf of Mexico.

ZONE NO. 50

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern), Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia), Kentucky (Western), Tennessee, Georgia.

BOUNDARIES—Northeastern: From Columbia, Tenn., via L. & N. R. R. to Baugh, Tenn. **Western and Southern:** From Columbia, Tenn., via L. & N. R. R. through Lawrenceburg to Iron City, thence east via Alabama-Tennessee state line to Baugh, Tenn.

ZONE NO. 51

RESTRICTED TO FOLLOWING COALS—Alabama, Kentucky (Southern), Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia), Tennessee, Georgia.

BOUNDARIES — Northern: Tennessee-Alabama state line. **Southwestern and Eastern:** Tennessee River.

ZONE NO. 52

RESTRICTED TO FOLLOWING COALS—Alabama.

BOUNDARIES—Northern and Eastern: Tennessee River to Alabama-Georgia state line, thence south along state line to Apalachicola River, thence via said river to the Gulf of Mexico. **Western and Southern:** Alabama-Mississippi state line to the Gulf of Mexico.

ZONE NO. 53

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern, also Western, to points on N. C. & St. L. and T. C. R. R. Nashville to Old Hickory and Hermitage, Tenn. inclusive), Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia, also Clinch Valley district in eastern Russell and Tazewell Counties), West Virginia (Eastern, also Southern, on C. & O. Ry. east of Charleston and N. & W. Ry. east of Iaeger, W. Va.), Georgia, Tennessee.

BOUNDARIES—Northern and Eastern: From Mitchellville, Tenn., east along Tennssee-Kentucky state line to Virginia state line, thence via L. & N. R. R. to Norton, thence via N. & W. R. R. through Roanoke, Petersburg (and branches of N. & W. R. R. at Petersburg) to Norfolk, thence south to Virginia-Carolina state line. **Western and Southern:** From Mitchellville, Tenn., via L. & N. R. R. through Nashville and Columbia to Baugh, Tenn., including Scottsville, Ky., branch, thence along Alabama-Tennessee-Georgia state line, thence via North Carolina-Tennessee state line, thence via North Carolina-Virginia state line to the Atlantic Ocean.

ZONE NO. 54

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern), Tennessee, Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia), Alabama, Georgia.

BOUNDARIES—State of Georgia and all of Florida east of Apalachicola River.

ZONE NO. 55

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern), Virginia (all Black Mountain and Stonega districts in Lee, Dickenson, Wise, and western Russell Counties of Virginia), Tennessee, Georgia, West Virginia (Eastern).

BOUNDARIES—Northern and Eastern: From Georgia-North Carolina-South Carolina state line to the line of the Sou. Ry. running south from Charlotte, N. C., through Chester to Columbia, S. C., thence via S. A. L. Ry. to Denmark, thence via Sou. Ry. to Charleston, S. C. **Western and Southern:** South Carolina-Georgia state line to the Atlantic Ocean.

ZONE NO. 56

RESTRICTED TO FOLLOWING COALS—Kentucky (Southern), Tennessee, Virginia (all Black Mountain and Stonega Districts in Lee Dickenson, Wise and western Russell Counties of Virginia, and Clinch Valley districts in Tazewell and eastern Russell Counties along the N. & W. Ry.), West Virginia (Eastern, on C. & O. Ry. and N. & W. Ry. and Virginian Ry.).

BOUNDARIES—All of North Carolina, and that portion of South Carolina on and east of the line of the Sou. Ry. Charlotte, N. C., through Chester to Columbia, thence via S. A. L. Ry. to Denmark, thence via Sou. Ry. to Charleston, S. C.

ZONE NO. 57

RESTRICTED TO FOLLOWING COALS—No change contemplated. Coal to be supplied generally from low-volatile fields.

BOUNDARIES—That portion of Virginia on and north of the N. & W. R.R. Graham, Va., to Norfolk, Va., including branches at Petersburg.

EXPLANATION OF ABBREVIATIONS AND TERMS USED

B. & O.	Baltimore & Ohio R. R.
C. & C.	Coal & Coke Ry.
C. & E. I.	Chicago & Eastern Illinois R. R.
C. & N. W.	Chicago & Northwestern Ry.
C. & O.	Chesapeake & Ohio Ry.
C. & O. N.	Chesapeake & Ohio Northern Ry.
C. B. & Q.	Chicago, Burlington & Quincy R. R.
C. C. & O.	Carolina, Clinchfield & Ohio Ry.
C. C. C. & St. L.	Cleveland, Cincinnati, Chicago & St. Louis Ry.
C. I. & L.	Chicago, Indianapolis & Louisville Ry.
C. M. & St. P.	Chicago, Milwaukee & St. Paul Ry.
C. R. I. & P.	Chicago, Rock Island & Pacific Ry.
E. R. R.	Erie R. R.
G. B. & W.	Green Bay & Western R. R.
G. H. & H.	Galveston, Houston & Henderson R. R.
G. R. & I.	Grand Rapids & Indiana Ry.
H. E. & W. T.	Houston East & West Texas Ry.
H. V.	Hocking Valley Ry.
I. C.	Illinois Central R. R.
K. & M.	Kanawha & Michigan Ry
K. & W. V.	Kanawha & West Virginia R. R.
L. & N.	Louisville & Nashville R. R.
L. F.	Long Fork R. R.
M. C.	Michigan Central R. R.
M. K. & T.	Missouri Kansas & Texas R. R.
M. R. R.	Middlesborough R. R.
M. St. P. & S. S. M.	Minneapolis, St. Paul & Sault Ste. Marie Ry.
N. & W.	Norfolk & Western Ry.
N. C. & St. L.	Nashville, Chattanooga & St. Louis Ry.
N. Y. C.	New York Central R. R.
P. & W. V.	Pittsburgh & West Virginia Ry.
P. C. C. & St. L.	Pittsburgh, Cincinnati, Chicago & St Louis Ry.
P. Co.	Pennsylvania Co.
P. M.	Pere Marquette Ry.
Q. & C.	Queen & Crescent Route.
S. A. L.	Seaboard Air Line Ry.
Sou. Ry.	Southern Ry.
St. L. I. M. & S.	St. Louis, Iron Mountain & Southern Ry.
St. L. S. F.	St. Louis-San Francisco Ry.
St. L. S. W.	St. Louis-Southwestern Ry.
T. & O. C.	Toledo & Ohio Central Ry.
T. C.	Tennessee Central R. R.
V. Ry.	Virginian Ry.
W. & L. E.	Wheeling & Lake Erie Ry.
W. M.	Western Maryland Ry.
W. Ry.	Wabash Ry.
Y. & O. R.	Youngstown & Ohio River R. R.
Z. & W.	Zanesville & Western Ry.
Summer	From Apr. 1 to and including Sept. 30.
Winter	From Oct. 1 to and including Mar. 31.

KENTUCKY

Eastern	All mines in eastern Kentucky on Sou. Ry. (Q.&C.), L. & N., C. & O., N. & W. and L. F.
Northeastern	Sandy Valley & Elkhorn Ry., L. F., C. & O., and N. & W. in Thacker, Big Sandy and Elkhorn districts.
Northern	L. & N. in Hazard and Elkhorn districts.
Southern	Sou. Ry. (Q.&C.) and L. & N. in Harlan, Jellico and Southern Appalachian districts.
Western	L. & N. and I. C. west of Louisville, Ky.

WEST VIRGINIA

Eastern	C. & O. and N. & W. in low-volatile fields of Pocahontas, Tug River and New River districts.
Northern	K. & M., K. & W. V. and C. & C. west of Dundon.
Southern	C. & O. and N. & W. in Kanawha, Kenova and Thacker districts.

KEY TO PRODUCING DISTRICTS

Location of Producing Districts	Numbers of Consuming Zones to which restricted
Alabama	40, 45, 46, 48, 49, 51, 52, 54.
Arkansas	5, 35, 36, 37, 39, 41, 42, 43, 44, 45, 46.
California	30.
Colorado	30, 31, 33, 35, 36, 37, 38, 39.
Docks[1]	1, 2, 3, 4, 4A, 6A, 31, 32, 33, 34, 41.
Georgia	50, 51, 53, 54, 55.
Illinois (summer)	2, 34, 41.
Illinois	3, 4, 4A, 5, 6, 6A, 7, 8, 9, 10[2], 11, 12[2], 15, 16[2], 20[2], 44, 45[5], 46[8].
Indiana	3, 8, 9, 10, 11, 12, 14, 15, 16, 20.
Iowa	24, 5, 74, 35, 36, 41, 42, 43.
Kansas	5, 35, 36, 37, 41, 42, 43, 44, 45.
Kentucky:	
Eastern	11, 14, 15, 16, 17, 19, 20, 21, 22.
Northeastern	23, 24.
Southern	18, 50, 51, 53, 54, 55, 56.
Western	3, 4, 6, 6A, 9, 10, 11, 13, 15, 40, 45, 46, 47, 49, 50, 53[8].
Maryland	57.
Michigan	14, 15, 20, 21.
Missouri	5, 35, 36, 37, 41, 42, 43, 44, 45.
Montana	30, 31, 32, 33, 34, 35.
New Mexico	30, 35, 37, 38, 39.
North Dakota	1, 2, 31, 32, 33, 34.
Ohio	14[9], 20, 21, 22, 23, 24, 25, 26, 27, 28[7], 29.
Oklahoma	5, 35, 36, 37, 39, 41, 42, 43, 44, 45.
Oregon	30.
Pennsylvania	27, 28, 57.
South Dakota	1, 2, 32, 33, 34.
Tennessee (M. R. R.)	11, 14, 15, 17, 18, 19, 20, 21, 22.
Tennessee	50, 51, 53, 54, 55, 56.
Texas	37, 38, 39, 40, 44, 45, 46.
Utah	30, 31, 33, 35, 36.
Virginia (L. & N.)	11, 14, 15, 17, 18, 20, 21, 22.
Virginia[8]	50, 51, 53, 54, 55, 56.
Virginia[9]	53, 56.
West Virginia:	
Eastern	19, 23[10], 24[10], 25[10], 29[10], 53, 55, 56.
Northern	14, 15, 20, 21, 23, 25, 29.
Southern	11, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 53.
Wyoming	30, 31, 32, 33, 34, 35.

[1]South bank Lake Superior and west bank Lake Michigan.

[2]From Danville district on Wabash Ry. only.

[3]Only on lines of St. L. I. M. & S. and St. L. S. W. Rys.

[4]To points in Iowa only.

[5]To points on N. C. & St. L. and T. C. Nashville to Hermitage and Old Hickory, Tenn., inclusive.

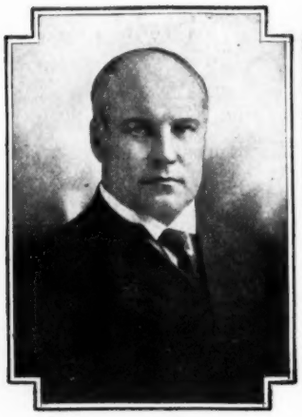
[6]On G. R. & I. only.

[7]From mines in Columbiana County, O., only.

[8]All Black Mountain and Stonega districts in Lee, Wise, Dickenson and western Russell Counties.

[9]Clinch Valley districts in Tazewell and eastern Russell Counties.

[10]Along lines of C. & O. and N. & W. to Cincinnati and Columbus, O.



The Government and The Water Powers

An Interview with

Hon. Franklin K. Lane

SECRETARY OF THE INTERIOR

IN THE hearings before the Special House Committee on the Administration's Water-Power Bill, Chairman Sims asked a number of questions which involved the right or the probable disposition of the Federal Government to take over and operate the properties upon the expiration of the license. At that time, under the measure before the committee, the Government would have its choice of three courses:

To take the property;

To transfer the privilege to another licensee;

To renew the license to the original holder.

Suppose, as likely to be the case, that there is no other applicant for the privilege; then the Government must either renew the license or take the project over and operate it. If the Government has no use for the power for purely governmental purposes such as making nitrates or munitions or operating possibly government-owned railways, could it make current for sale? Has it the right under the Constitution to go into the business of supplying electricity for light, heat and power, and water for irrigation commercially? If so, is it entitled to do so at a profit or would it have to furnish the current at cost? Would it be possible against powerful opposing influences to get Congress to vote a huge appropriation for the purpose of going into business in competition with an industry the recent growth of which is significant of what it will come to be in fifty years?

Would License Be in Effect a Grant in Perpetuity?

If the Government were found to be unauthorized to take over such a project and operate it commercially or if the objections to doing so were insuperable, would it not be reduced to the necessity of renewing the license to the original holder and that upon his own terms? Would not the license under such circumstances be in effect a grant in perpetuity?

This phase of the question evoked so much interest and discussion among those present at the hearings and others that we sought an expression from Secretary Lane, whose experience in former connections as well as in his present administrative position gives especial weight to any utterance of his upon the subject.

The Secretary expressed the opinion that the license would not, in effect, be a grant in perpetuity, for the reason that the bill provides that a renewal in such case shall be upon such terms and conditions as may be prescribed by the then existing laws, affording Congress ample opportunity to impose such new terms or conditions as the public interest shall then be deemed to require. The Government will not be required to renew the license upon the original holder's "own terms," because if the United States does not take over the properties itself or find another applicant who will take them, the original licensee must accept any condition offered or abandon his property and lose his whole investment.

As to the right of the Government to acquire and operate such a project, Mr. Lane thought there could be no doubt. The Salt River reclamation project, he said, "which I have turned over to the water users for operation," is practically paying its own way out of the power developed under the Roosevelt dam. The Shoshone reclamation project in Wyoming, built by the Department, is furnishing water for irrigation and electricity to towns and industries within a wide radius, as is also the project at Minidoka, Idaho.

Government Right to Sell Water and Electricity

"Has the right of the Government to sell water and electricity ever been questioned?" we asked.

"Never," replied the Secretary. "If it were, how would you justify it? There is probably no inhibition, but it is urged by the opponents of Government activities of this sort that among the powers conferred upon the Federal Government by the constituent states there are none which can be construed to warrant such undertakings.

"I know of no inhibition in the Constitution or elsewhere upon the right of the Federal Government to develop water power and dispose of the product to the public," said the Secretary. "Under the Constitution, the Federal Government has jurisdiction and authority over the navigable waters of the United States, under which authority dams and other works for the improvement of navigation are constantly being constructed. Many of these structures involve the incidental development of water power, and there can be no question, I think, of the right of the Government to utilize this incidental value for the benefit of the public and to secure a return to the Federal Treasury of a part of the expenditures made for such improvements.

Right of Congress to Dispose of Public Lands

"As to the public lands, the Constitution vests in Congress full authority to 'dispose of' the same. The Supreme Court has stated that Congress may deal with

these lands precisely as an ordinary individual may deal with his property, and that as the lands are held in trust for the people of the whole country, it is for Congress to determine how they shall be handled. For instance, Congress has a right to establish forest and other reservations for public purposes, or to devote lands to some other national or public purpose. These are rights incident to proprietorship, to say nothing of the power of the United States as a sovereign over the property belonging to it. Furthermore, the so-called general welfare clause of the Constitution has been given a very liberal construction and indicates the intention of the framers of the Constitution to confer very broad powers upon the Federal Government for the public good. The Government was created by the people and is operated for their benefit. If the public interest warrants or requires the development of electrical power and its sale by the Federal Government, the Constitution seems to fully warrant the undertaking.

"But," continued the Secretary, "would not the probable outcome be that the municipality, which would naturally grow up about one of these developments, would acquire it on the expiration of the license? A project too large for a municipality or a drainage or other district could be acquired by the state. There is no doubt of the competency of any state to enter upon such an undertaking, and the competency of a municipality or district is a matter of state legislation. In view of the present tendency of public opinion one can well imagine a general disposition on the part of communities to own their own public utilities by the time these licenses begin to expire."

Public Ownership of Public Utilities

We acknowledged our sympathy with the tendency and the probability of the suggested outcome so far as public utilities were concerned. "But what," we asked, "would happen in the case of a project which served only special industries; big metallurgical works, for example? If a license were granted to a syndicate of paper manufacturers to develop a power for the manufacture of paper, what could the Government do with that on the expiration of the license, and would it have any control of the project in the meantime? Not being a public utility, would it come within the jurisdiction of a public-utility commission or similar body? Could the Federal commission control it? If the commission undertook to recover exorbitant profits by the imposition of a high rental, they would simply pass the charge on to the consumer."

Secretary Lane thought that this would be a very exceptional case. "A community would undoubtedly grow up about such an industry and the water power would supply the needs of that community and so become to an extent a public utility, sufficiently so perhaps to warrant the community in taking it over. Most public utilities furnish power as well as light, and their status as public utilities is not determined by the proportion of their output sold for power or the number of their power customers. As to rate control during the term of the license, the syndicate would have to sell in competition with other manufacturers and the growing sentiment in favor of restricting prices to cost plus a fair profit and legislation against control of production and distribution could be depended upon to prevent an abuse of the privilege or its use for speculative purposes. The time is long past, and wise men see that it is past, when there is a speculative value in these things. The right of the community, of the nation, of the collective body of citizens that we call the people of the United States, their right is superior to any right that you or I may have to speculate upon those things that are primary resources."

"What is your attitude, Mr. Secretary," we asked, "toward the initial development of the powers by the Federal Government?"

"If we had money enough," said Mr. Lane; "if this were not a time of war; if we could think in the terms of money that we are now thinking of; or if four or five years ago Congress had been willing to expend hundreds of millions of dollars in the development of water power as it is forced now to spend billions of dollars for war—then it would be a wise thing to put a large part of the public revenues into such projects where they are found to be needed. I have no doubt in my own mind that such schemes as water-power developments are perfectly practicable from a governmental standpoint, no matter what your sympathies may be respecting Government ownership, as a rule, of large utilities. A thing that is as well standardized as a water-power scheme can be operated successfully by the Government. But I do not think that this is practicable at this time nor probably will it be for many years to come, and it is necessary that there should be real development, and that soon.

"The water powers should be given into the hands of the men capable of developing them under such conditions as will warrant large investment. We cannot save things for men who have no capital, or men who go about things with a spade where a steam shovel is needed. The conditions under which these privileges are granted should guard against extortion during their use and insure the return of the resource to the people at the termination of the license if the people want to take it back by refunding the net investment. The term of the grant should be long enough to afford the promoter or *entrepreneur* an opportunity to make a profit commensurate with his risk and enterprise, and to attract the necessary interest, talent and capital to get some good out of these powers for the present generation and stop our extravagant incursions upon the supply of fuel that is of increasing value for other than power purposes. The bill before Judge Sims' committee is designed to do this and seems to promise to do it better than any measure previously offered."

Our Government wants to spend 19 billion dollars this year, a sum so vast that it cannot be comprehended. From 1791 to Jan. 1, 1917, a period of 126 years, the Government spent only 26 billion, 300 million for all purposes—for wars and in times of peace, for pensions, for the Panama Canal, and for every other expense of the Government. This is only about five billion dollars more than has been appropriated by Congress to be spent in one year to provide for the tremendous demands of the war. This sum cannot be borrowed except from the people. It cannot be raised except by taxation or loans from the current income of the people. We must save and lend our savings to the Government.

What is the Capacity of a Turbine?

In "Power" for Mar. 19 appeared an editorial on the question which forms the title above. There is renewed interest in the subject. In the editorial those interested were invited to express their opinions. Some are given in this article.

THE Power Test Code of the American Society of Mechanical Engineers, page 30, paragraph 23, reads as follows: "The commercial rating of capacity determined on for power-plant apparatus, whether for the purpose of contracts for sale, or otherwise, should be such that a sufficient reserve capacity beyond the rating is available to meet the contingencies of practical operation; such contingencies, for example, as the loss of steam pressure and capacity due to cleaning fires, inferior coal, oversight of the attendants, sudden demand for an unusual output of steam or power, etc."

Needless to say, this paragraph is controversial, and is the subject of serious consideration by the Power Test Committee of the society, which committee is now revising the code.

The Prime Movers Committee of the National Electric Light Association has not expressed itself on this question of turbine capacity. The Association of Edison Companies has not declared what it accepts or agrees is the capacity of a turbine, neither has the American Institute of Electrical Engineers so far as the writer can learn. This much may be said: Most engineers responsible for the selection and operation of large turbines, particularly, agree that if a turbine guaranteed to give a specified capacity at specified conditions of steam pressure, superheat and vacuum gives the specified capacity, the builder has fulfilled his obligations though not one kilowatt more than that capacity can be got, the steam pressure, superheat and vacuum being the same.

The expressions which follow are by men prominent in turbine and power-station development; all are anonymous.

From a user: The writer has closely followed turbine development practically from its start, and was not aware that there was any active question about turbine rating at this time. If, however, this question is active, the American Society of Mechanical Engineers should investigate and report upon the subject.

Another procedure which I would suggest is to submit this matter to the consideration of the Prime Movers Committee of the National Electric Light Association and the Steam Plant Committee of the Association of Edison Illuminating Companies. Both of these bodies are composed of the leading men in the electrical industry, all of whom have given much thought to turbine matters.

In the earlier days of turbine development it was customary to apply two ratings to a machine; namely, normal capacity and maximum capacity. This double rating was objectionable and has been abandoned. Today, turbines are rated on maximum capacity based on steam pressure at the throttle, or in the bowl, superheat and vacuum. These conditions are applied to a steam engine, and there is no uncertainty in the mind of anyone about the performance of the engine. They apply just as well to the turbine. When these conditions are complied with by the purchaser and the guaranteed kilowatt load is developed by the turbine, the purchaser is getting what he purchased, and he has no more grounds for asking that he should get a greater output than he would have to expect a grocer to sell him a pound and a quarter of sugar when he ordered a pound.

The character of the station load has nothing to do with the capacity of the turbine. Load fluctuations vary with different stations, and they vary from hour to hour in any station. The turbine manufacturer does not know and is not concerned about this; that is a matter of engineering on the part of the purchaser. If the latter does not properly do his engineering the turbine manufacturer should not be blamed.

As a matter of fact, I think the thought that inspired the editorial was not the determining of the capacity of a given turbine when steam conditions are fixed, but determining what capacity turbine should be installed to meet load conditions in a given station. This is a matter that cannot be governed by any set of rules, but must be determined for each specific case.

From a designer: It is not surprising that there should be revived the question, "what is the Capacity of a Turbine," notwithstanding all that has been written on the subject. The bald statement of so many kilowatts capacity means nothing without more explanation, and if one desires to state the capacity, more explanation is necessary. This is rightly so, for in accordance with the required service some turbines are designed to have very large and others very small capacities above the point at which their steam consumption is best, all depending upon the load factor. This perhaps has been rendered more aggravating by a tendency on the part of salesman and purchaser alike to say their turbine is as big as they can stretch it. It is not uncommon for a turbine and generator to be called upon to sustain a load 100 per cent. in excess of the average load for a limited time; which gives opportunity for a wide disparity of rating.

The old Corliss engine practice of giving an engine an arbitrary overload capacity of 50 per cent. would seem to have no place today because of the varying load factors that obtain; for example, in large lighting systems on the one hand, where a turbine, if operating at all, is operating close to its point of best steam consumption, a very small percentage capacity above this is needed. On the other hand there are other plants, railroads, for example, where the turbine is called upon to sustain heavy peak loads and swings, sometimes requiring a capacity 100 per cent. in excess of the point of best steam consumption.

It is certainly convenient to specify the rating of the generator at its maximum continuous capacity, and so far as the generator itself is concerned, there need never be confusion. With the turbine the matter is more difficult, and this is made doubly so by its extreme flexibility. A turbine designed to pass a given number of pounds of steam, if designed with proper regard to the volumes of steam, will give the best performance

with a flow of this quantity. It requires no particular ingenuity on the part of the designer to find means of passing a much larger quantity of steam through the turbine, permitting much greater loads, with some impaired efficiency.

If your question is prompted by considerations of the safety of the turbine under overload, as seems to be implied, then it may be said that with full specified pressure behind all the nozzles with which the turbine is equipped, or, if bypassing is resorted to with full pressure at these secondary points of admission, no dangerous pressure should obtain in any of the lower stages. In other words, the turbine is defective if it cannot be caused to slow down by an excessive overload without injury to the turbine. This also with allowance for a reasonable increase of pressure beyond that specified and also with a simultaneous loss of vacuum which in itself will cause increase of pressure in certain of the low-pressure stages.

It may be thought desirable by some people to state in a word the capacity of a machine which rather more expresses its monetary value, or its physical dimension for the same reason that many years ago prompted the use of the term "nominal horsepower."

Is not the matter entirely covered and made clear by merely stating the kilowatts capacity at the point of best steam consumption, and in addition the maximum continuous kilowatts capacity; the latter being the extreme load the turbine is warranted to sustain when operating under the specified operating conditions? The former in a measure expresses the size of the machine. To describe the complete unit one should further amplify this by quoting the maximum continuous rating of the generator, which is not necessarily the maximum capacity of the turbine.

From a user: Before the days of large steam turbines the commercial rating of reciprocating engines was established by common practice at about 85 per cent. of their maximum capacity, which gave considerable overload capacity to meet the swings which might demand capacities above the commercial rating.

When turbines entered the field it quite naturally followed that their rating should be calculated on the same basis, and in addition, the turbine designers, lacking in experience and data combined with a desire to produce the required horsepower in their machines, very much underestimated their capacity, and in comparison with the generators turbines were much overpowered and furnished almost unlimited overload capacity. Sometimes the capacities were as high as 100 per cent. above builder's rating. It is not difficult to see that this condition would eventually adjust itself to a more accurate basis for calculating capacities when the experience in operation had demonstrated that turbines were, in comparison with reciprocating engines, much underestimated, with the result that today machines are rated at 7500 kw. which in former years were sold for 5000-kw. machines. The former has led to confusion when referring to turbine capacities, producing a new term, "maximum capacity," to denote the physical limit of output as compared with the old commercial rating.

At present contracts for turbines are drawn with the understanding that with a given steam pressure, superheat and vacuum they will develop their maximum rating. As it is difficult to design a turbine so that it will develop its rated capacity and no more, there is generally a slight reserve capacity above the rated capacity. Should a turbine purchased as a 10,000-kw. machine on test develop 11,000 kw., the purchaser has a 10,000-kw. rated machine with capacity of 11,000-kw.; but it does not follow that all 10,000-kw. machines will carry 11,000 kw. Under the same contract conditions should the turbine develop 10,000 kw. only as its maximum load, the contractor has met his obligations. Should the turbine fail to carry the rated load when the conditions of pressure, temperature and vacuum are not met with, the machine does not in any sense become one of lower capacity.

As all turbine installations should include recording instruments to measure the load, vacuum, pressure and temperature, the question of conditions under which a machine might fail to maintain its speed is easily determined.

The load to be reported to the public service commission from the operating station should be maximum hour, maximum of 15 min. and the maximum swing.

The writer of the first communication mentions that the question of what capacity turbine should be installed to meet load conditions in a given plant may have been the thought which prompted the editorial. While the questions of capacity of a particular turbine and of what capacity turbine or turbines should be installed for given load conditions are separable, they are, of course, closely related, one greatly influencing the other.

This latter question has always been a controversial one; but since the introduction of turbines of large capacity—units of 30,000 and 35,000 kw. are becoming numerous and some of 60,000 kw. are being built—it has become more unsettled. This question, which is that of what reserve capacity to allow, also is one demanding consideration by individuals and the engineering societies.

How Is This for Red Tape?

Considerable has been said about the water-power developments of this country being tied up with governmental red tape, but how about Italy? E. Strachan Morgan, writing in the London *Electrical Review* on, "Electrical Developments in Italy," says:

> There were a short time ago lying in the Ministero delle Finanze 2600 demands for water-power concessions, some of which had been on file for more than 20 years. Even by the provisions of the Villa Bill, drafted with a view to simplifying procedure, every demand goes through twelve stages. It goes to the Prefetto, to the Genio Civile, to the Magistrato Supremo delle Acque in Rome, then back to the Prefetto, to the Deputazione Provinciale, then back to the Genio Civile, which at last orders a survey of the local conditions, then back to the Magistrato Supremo in Rome, then to the Ministero dei Lavori Pubblici, then back to the Magistrato Supremo, then to the Ministero delle Finanze, at whose recommendation the concession may be granted by a Decreto Reale. It does not take much knowledge of bureaucratic procedure to realize what considerable possibilities of delay there are even in this "express" treatment of a demand.

Show your patriotism by contributing to the American Red Cross Fund.

Determining of Load Centers of Circuits*

BY TERRELL CROFT

The object of this article is to explain the location of load centers of electric circuits in a way that it can be readily understood. The results given by the methods indicated, are not absolutely accurate, but they are sufficiently so for all practical purposes.

THE location of the load center of a circuit with a distributed load must be determined before any wiring formula can be correctly used for it. The load center of a circuit is that point at which the total load on the circuit can be assumed to be concentrated when making wiring calculations. An electrical-load center is somewhat analogous to a center of gravity of a body. To illustrate, in Fig. 1 all of the eight lamps are of the same size and equal distances apart. The load center for the branch circuit lying between switch S and the last lamp B is at AA; that is, it is at the middle of the group of lamps. The distance from the starting point S of the circuit to the load center, denoted by D, would be used for the distance D in the direct-current formula, cir.mils. $= \frac{22ID}{E_d}$. The voltage drop E_d in the formula would be the drop in the circuit from the switch S to the last lamp B. The current I of the formula would be the total current taken by all of the eight lamps, or for any condition the sum of the amperes taken by all the elements on the circuits. If the conductors were calculated for a drop of 5 volts, the drop between S and B would be 5 volts. Then if the electromotive force impressed at S is 110 volts, the pressure at lamp B, with all lamps burning, will be 110 — 5 = 105 volts. The other seven lamps in the group would be subjected to somewhat greater voltages. The pressure would increase slightly at each successive lamp in the direction of the switch; lamp C would receive the highest pressure of the group.

In practice the location of the load center is seldom determined by calculation. An approximate location is assumed, the position of which is determined by inspection of the loads on the circuit and their positions. Considerable experience is necessary before the center can be thus located by inspection with a fair degree of accuracy. The beginner should compute several cases until he is familiar with the principles involved. A high degree of accuracy in the location of the load center is not essential, because there are other factors entering into wiring calculations that usually cannot be accurately determined.

The load center of a group of receivers symmetrically arranged and all of the same capacity will be in the middle of the group, as indicated in Figs. 1 and 2. The distance denoted by D in the wiring calculation formula is the distance from the beginning of the circuit under consideration to the load center, measured along the circuit.

The load center of a group of receivers unsymmetrically located or of unequal capacities is found by first multiplying the normal-ampere capacity of each receiver by its distance from the beginning of the circuit under consideration, second, adding all these products together, and third, dividing this sum by the total current of the circuit. The quotient thus obtained will be the distance in feet of the load center from the starting point of the circuit. In Fig. 3 there are three loads of 100, 40 and 20 amperes located 80, 100 and 130 ft. respectively from the switch S at the source of supply. To find the location of the load center as explained in the foregoing, first multiply the distance in feet each load is from the beginning of the circuit, by the normal amperes of the load corresponding to each distance. Thus:

80 ft.	× 100 amp.	=	8,000 amp.-ft.
100 ft.	× 40 amp.	=	4,000 amp.-ft.
130 ft.	× 20 amp.	=	2,600 amp.-ft.
Total,	160 amp.		14,600 amp.-ft.

Then the total ampere-feet divided by the total current is 14,600 ÷ 160 = 91.25 ft., equals the distance the load center is from the beginning of the circuit as shown in the figure.

Instead of measuring all the distances from the beginning of the circuit, they can be measured from the first receiver of the group; then the resulting distance to the load center will be measured from the first receiver of the group. The example Fig. 4, illustrates this method. Multiplying the distance in feet of each receiver from the first load by each load in amperes, the result is:

0 ft.	× 100 amp.	=	0 amp.-ft.
20 ft.	× 40 amp.	=	800 amp.-ft.
50 ft.	× 20 amp.	=	1,000 amp.-ft.
Total,	160 amp.		1,800 amp.-ft.

Then dividing the total ampere-feet by the total amperes, 1800 ÷ 160 = 11.25 ft., equals the distance in feet from the first load to the load center. This value plus the distance from the beginning of the circuit to the first load is the distance that the load center is from the supply end of the circuit, in this case equals 80 + 11.25 = 91.25 ft., as indicated in Fig. 4. This result is the same as that obtained with the method given in Fig. 3. However, it should be noted that these methods are not absolutely correct, because they assume that each receiver takes its normal current. This assumption is not a true one, because the voltage at the farther end of a circuit is lower than that at the near end. Consequently, the same lamps or other receivers will pass more current if located at the near end of the circuit than at the far end. Nevertheless, these values are accurate enough for use in wiring calculations.

Where no energy is taken from a circuit except at its end, the distance D used in the formula for circular mils, is the entire length of the circuit. This is illustrated by the example in Fig. 5. Here the only load on the circuit is one of 100 amperes at the end of the line, 250 ft. from the supply main. Then the load center is at the point AA in the circuit, or where the load is located. With a 100-ampere load and a 5-volt drop in the line, the size of conductors required is

$$cir.mils = \frac{22DI}{E_d} = \frac{22 \times 250 \times 100}{5} = 110{,}000$$

*Copyright, 1918, by Terrell Croft.

The problem, Fig. 6, will further illustrate how a load-center value is used and is typical of those which are often encountered in practice:

A direct-current circuit is to supply a total load of 155 amperes. This load is subdivided into minor loads of 35, 15, 60 and 45 amperes, located respectively 180, 200, 280 and 325 ft. from the source of energy, as indicated in the figure. The permissible drop in the circuit is 5 volts. Where is the load center located? What size conductors should be used to insure that the drop to the last load on the circuit (the 45-ampere load) will not exceed the permissible drop $Ed = 5$ volts?

To find the location of the load center the procedure indicated in Fig. 3 may be followed, thus:

180 ft.	×	35 amp.	= 6,300 amp.-ft.
200 ft.	×	15 amp.	= 3,000 amp.-ft.
280 ft.	×	60 amp.	= 16,800 amp.-ft.
325 ft.	×	45 amp.	= 14,625 amp.-ft.
		155 amp.	40,725 amp.-ft.

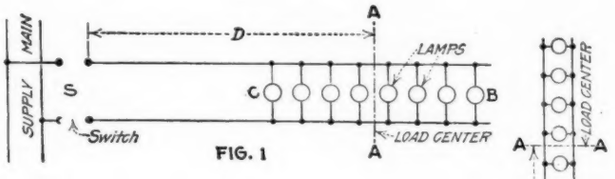


FIG. 1

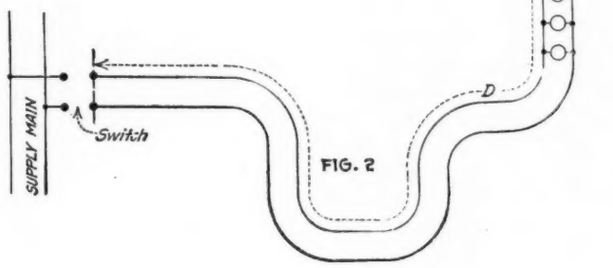


FIG. 2

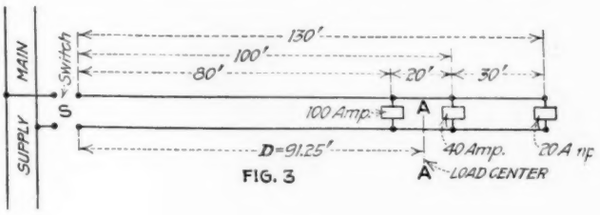


FIG. 3

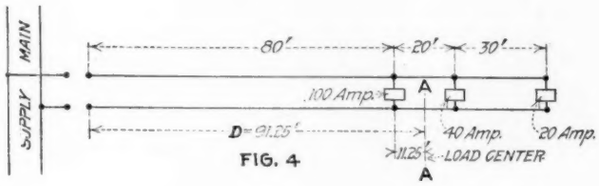


FIG. 4

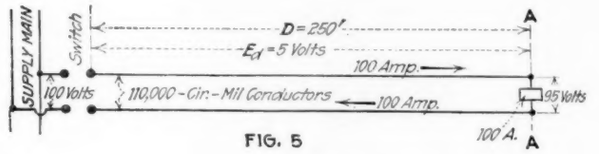


FIG. 5

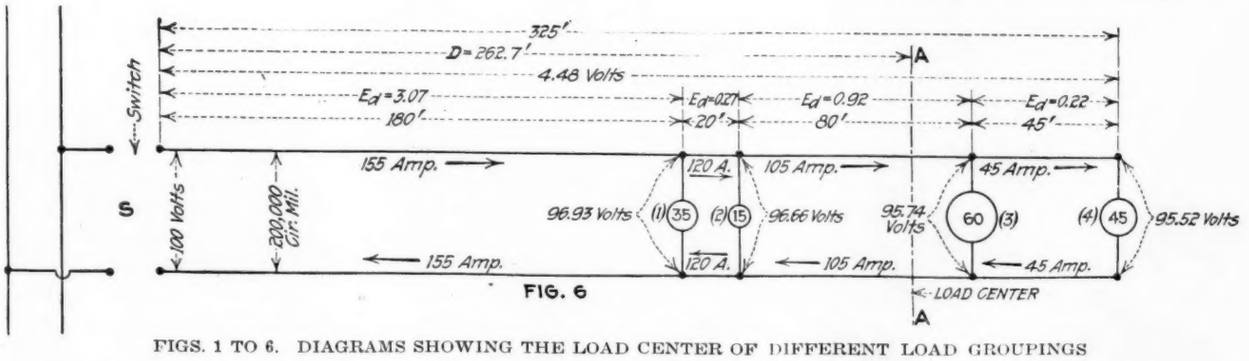


FIG. 6

FIGS. 1 TO 6. DIAGRAMS SHOWING THE LOAD CENTER OF DIFFERENT LOAD GROUPINGS

The total ampere-feet divided by the total amperes is 40,725 ÷ 155 = 262.7 ft. approximately. Therefore, the load center is the distance $D = 262.7$ ft., as shown in the figure, from the source of energy. The current I is 155 amperes, then the size of the conductors required to not exceed the 5 volts drop in the line is

$$cir.mils = \frac{22DI}{Ed} = \frac{22 \times 262.7 \times 155}{5} = 179{,}161$$

The next size larger standard conductor is 200,000 cir.mils. and is the size that will have to be used. This size conductor will give a slightly less volts drop in the line than the size calculated on account of having less resistance.

The volts drop and current in the different sections of the circuit, the distances and the voltage at each receiver, are shown on the figure. The total drop to the last load is 4.48 volts. The drop in each section was computed by the formula:

$$E_d = \frac{22DI}{cir.mils}$$

where D is the length in feet of each section. Hence the volts drop in the first section is $E_d = \frac{22 \times 180 \times 155}{200{,}000} =$ 3.07 volts,

in the second section, $E_d = \frac{22 \times 20 \times 120}{200{,}000} = 0.27$ volt,

in the third section, $E_d = \frac{22 \times 80 \times 105}{200{,}000} = 0.92$ volt,

and in the fourth section, $E_d = \frac{22 \times 45 \times 45}{200{,}000} = 0.22$ volt.

The difference between the voltage at the switch and the volts drop in the first section will give the volts at load No. 1, or 100 — 3.07 = 96.93; the difference between the voltage at the first load and the volts drop in the second section will give the volts impress at the second load, or 96.93 — 0.27 = 96.66 volts; at the third load the volts equal 96.66 — 0.92 = 95.74 volts; and at the last load the volts equal 94.74 — 0.22 = 95.52 volts. This makes the volts drop in the line 4.48 instead of 5, as assumed at the beginning on account of the conductors being slightly larger than the theoretical size calculated.

"John Crane" Flexible Metallic Packing

Flexibility and compressibility are necessary features in a packing which must also possess the ability to prevent pressure from leaking past it. In order to meet these requirements, the "John Crane" flexible metallic packing is made by taking long thin continuous strips of metal foil and wrapping them spirally around and around and back and forth and coating each sheet with a layer of lubricant, Fig. 1, the purpose of which is to permit the metal strips to slide on each other and to allow bending about the smallest diameter rod and at the same time giving it compressibility sufficient to compensate for wear and to control any leakage at ordinary pressures.

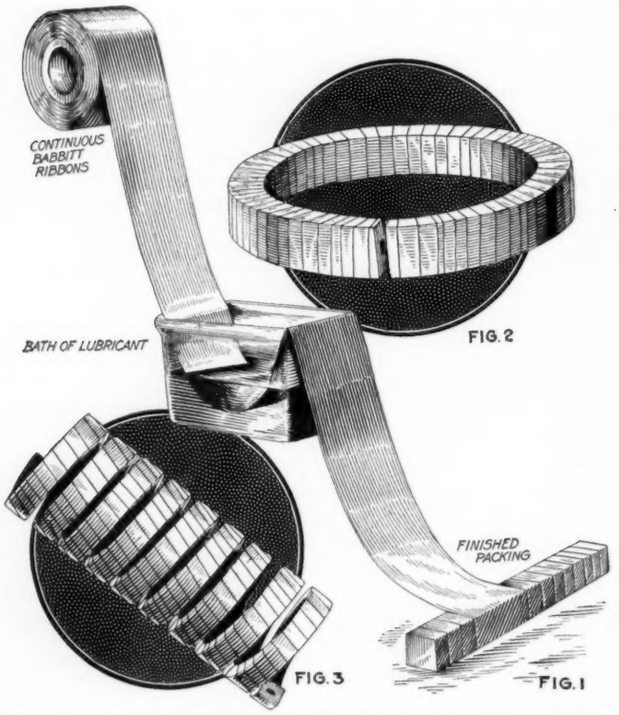
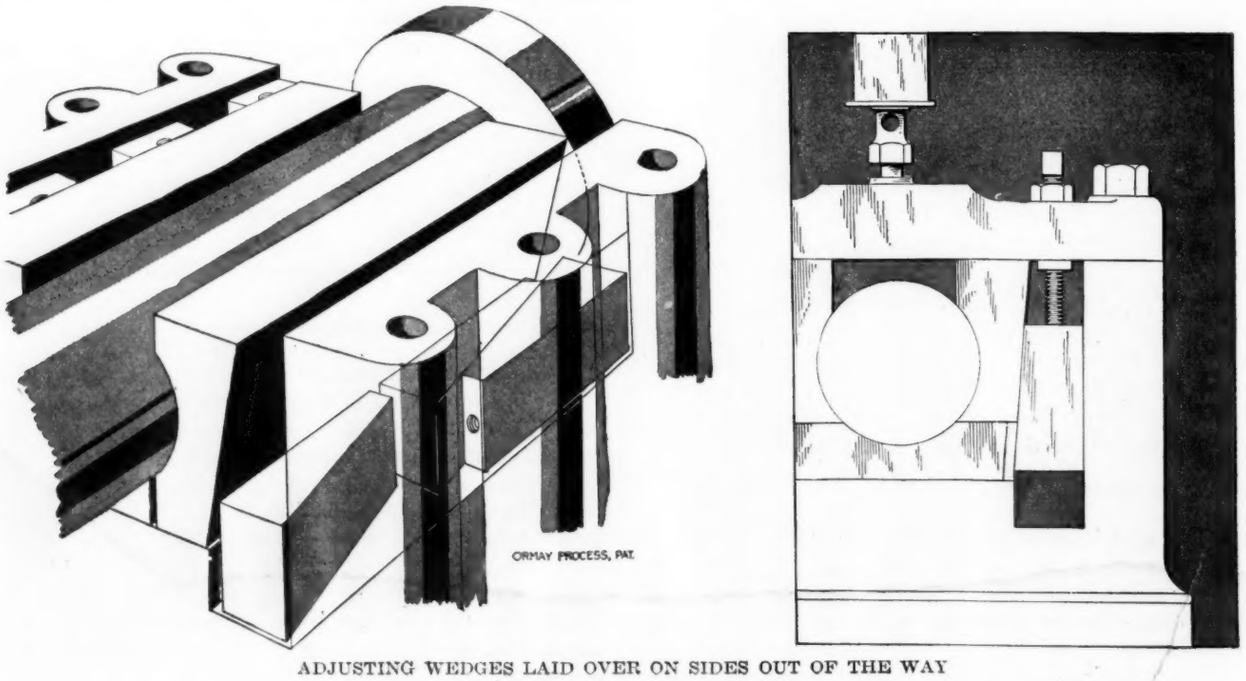


FIG. 1. LUBRICATING THE METAL STRIPS. FIG. 2. RING PACKING. FIG. 3. SPIRAL PACKING

The antifriction metal of which the packing is made is so soft that it can be easily cut with a knife and it will take any shape. This packing, made by the Crane Packing Co., 29 South Clinton St., Chicago, Ill., is in a large number of forms, such as straight lengths, rings, and spirals, from $\frac{1}{32}$ in. to 2 in. in size. It is suitable for steam, ammonia, hot and cold water, both high- and low-pressure; hydraulic, oil and acid service. The ring and the spiral forms of packing are shown in Figs. 2 and 3, respectively. The rings are generally preferred for large plungers, and the spiral coils are used on small work, such as valves and small steam rods.

Removing Main-Bearing Quarter Blocks

Lacking the right "twist of the wrist," a simple job sometimes becomes an ordeal. For example, it became necessary to remove the quarter blocks from the main bearing of a Buckeye engine. After taking off the cap and dropping the three adjusting wedges as far as they would go, the bearing would not lift out. The wedges were "big end down" and would not come out, of course; the governor was over too close to allow them to come out sidewise, and to shift the governor over on the shaft was "some job"—this was done once, but was not bragged about later when the right way was found. The fact that this (shifting the governor) was done by the engineering staff of a steel company seems to justify writing this. All there is to getting the wedges out of the way is to move two of them over to one side enough to allow the other to be laid over on its side (small end toward the others) then the middle one can be laid over alongside of it (small end toward the large end of the first one) and pushed over enough to allow the third one to be laid over on its side. This leaves "all kinds of room" to handle the quarter block.



ADJUSTING WEDGES LAID OVER ON SIDES OUT OF THE WAY

Favorable Performance of High Setting

By H. L. Strong

Though modern practice has proven the desirability of setting boilers well up from the fire and leaving ample room for the complete burning of the gases, it seems difficult for many to grasp the idea and apply it in practice, especially when applied to horizontal tubular boilers.

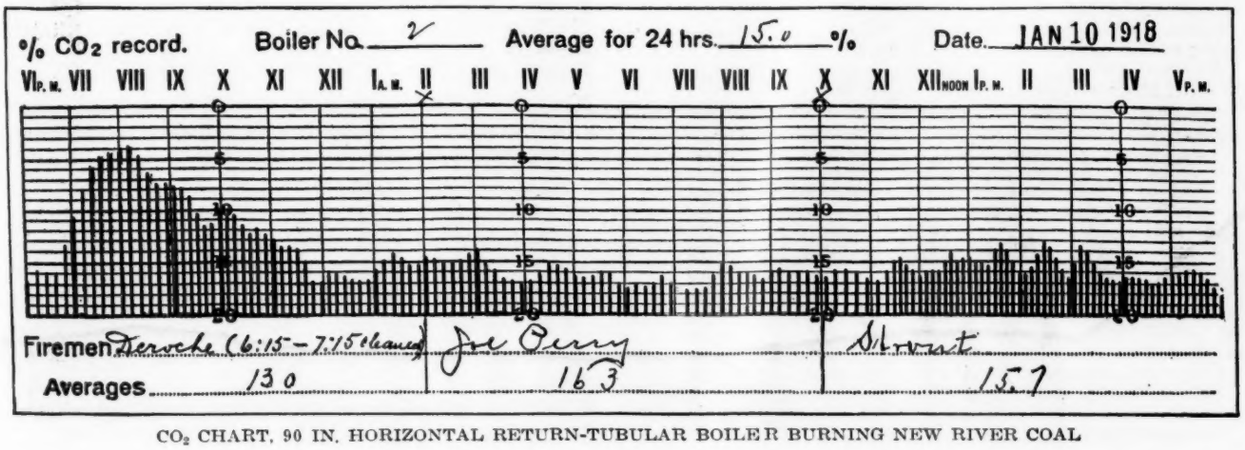
I have found that low settings, especially for boilers that are forced, give the following troubles: Reduced capacity, less efficiency, smoke, severe conditions for the fire sheets, rear tube sheets and tube ends, also severe service for the firebrick linings, and excessive deposits of ash in the combustion chamber, which become fused and difficult to remove. New River coal is used. We have in our plant four 90-in. return-tubular boilers set 38 in. above the grate, and it requires careful firing to obtain 12 per cent. CO_2. The flow meters will register 800 hp. on heavy driving. The outside lap of the first girth seam on all four boilers became burned and cracked and it was necessary to electrically weld the seams and rivets.

The combustion chambers fill rapidly, and we have to loosen the deposit with a pick and clean it out at least every fourth week. The firebrick linings deteriorate rapidly, and ash deposits fuse onto the walls back to and including the rear wall and have to be broken off with picks and bars. These are hand-fired boilers having shaking grates, set level. With the exception of the height of setting and level grates, these boilers are identical with the setting of the fifth one of this type, which we installed during the summer of 1917 and which is described here. The new boiler is set 5 ft. 4 in. above the dead plate. The grate is of the shaking type, built in four sections, and half of each section shakes separately. The grate is 7 ft. deep and 12 ft wide, the furnace design being such that the grate projects 2 ft. 3 in. beyond the boiler on each side. The grate pitches to the rear one inch to the foot, or seven inches in all. The height from the rear end of the grate to the shell is 5 ft. 11 in.; height of bridge-wall, 2 ft. 3 in. A considerably higher bridge-wall was tried in connection with a hand stoker grate having 1 ft. 8 in. pitch in 7 ft., but the heat was so intense that it melted out this bridge about as fast as we could repair it. The distance from the bridge-wall to the shell is 3 ft. 8 in.; extreme height of furnace, 8 ft. 9 in.; distance from combustion-chamber floor to shell, 6 ft. 6 in.; from rear head to rear wall, 2 ft. 8 in.; width of combustion chamber, or setting beyond grate, practically the same as the diameter of boiler, or 90 in.

Unfortunately, we made no test of this boiler, and some valuable information is therefore not available. This boiler raises steam from cold water quicker than the lower-set boilers. The capacity is greater when driving on peak loads; for under conditions where the others do 800 hp., the new one frequently shows 1000 hp. on the flow meter. Any reasonably good firing will maintain 15 per cent. CO_2 on the recorder, and I have never yet found more than a trace of CO. The extreme variation of load and consequent draft irregularity (0.25 in. to 0.5 in. over the fire) is favorable to CO production, too. The accompanying CO_2 chart was made on an ordinary run. Between 6:15 and 7:15 p.m. the fire was cleaned, which accounts for the condition shown. We allow one hour from the time cleaning is started until the fire is again in working order. When it is understood that this fire, burning New River run-of-mine coal and carrying 0.5 in. draft over the fire, is about twelve inches thick, it will be appreciated that cleaning 84 sq.ft. of grate and trimming off the clinker is not an easy job.

When in doubt about the accuracy of our recorders, we check them with the Orsat, and at the time this chart was made the recorder agreed exactly with the Orsat. Some years' experience with gas analysis has convinced me that a high percentage of CO_2 is not so dangerous to economy as many think, especially when there is careful and efficient supervision. I have found the worst cases of CO in samples having 12 to 13 per cent. CO_2 If a recorder shows 15 to 17 per cent. CO_2, it is fairly safe to say that there is not much, if any, CO present. I do not recall that I ever found over 1 per cent. CO in a sample of 15 to 17 per cent. CO_2 and more frequently none; I have, however, found 4 per cent. CO in samples containing 12 or 13 per cent. CO_2. During the 24-hour period of this CO_2 chart, the lowest uptake temperature (aside from the cleaning period) was 400 deg. F., the highest 525 deg. F. and the average 474.2 deg. F.; the average temperature of the fireroom, 75.7 deg. F.

[The performance between 3 a.m. and 12.30 p.m. that is, 15 per cent. CO_2 or better without a break, is indeed commendable for a hand-fired plant; in fact, it is a remarkable performance.—Editor.]


% CO2 record.
Boiler No. 2
Average for 24 hrs. 15.0 %
Date. JAN 10 1918
VI P. M. VII VIII IX X XI XII I A. M. II III IV V VI VII VIII IX X XI XII NOON I P. M. II III IV V P. M.
Firemen Dercke (6:15 - 7:15 cleaned) Joe Berry Strout
Averages 13.0 16.3 15.7

CO_2 CHART, 90 IN. HORIZONTAL RETURN-TUBULAR BOILER BURNING NEW RIVER COAL

What Your Red Cross Dollars Do*

LESS than a year ago the Red Cross called upon the American people for a fund of $100,000,000 with which to finance the tremendous work of relief and reconstruction that was vital to our Allies and ourselves, if the German terror was to be beaten back.

And so the call came for the First War Fund, and in one week America's answer went echoing back to Europe —more than a hundred million was freely given to make the world fit for democracy. At that time the membership of the Red Cross was less than two million. In six months it had increased to five million and with the Christmas membership drive the enrollment sprang in one mighty bound to 22,000,000 loyal supporters of this perfect embodiment of the nation's purpose in this war.

Today the American Red Cross is the largest organization of any kind in the world and the greatest force for good. In the black welter of warring nations it is the one bright spot of Hope—Humanity's Light.

With such a vast working force behind it there will never be any doubt that the tremendous work, which in the last twelve months has been barely started, will be upheld and continued throughout the war until its ravages have been restored. For this purpose the American people are going to be asked to contribute $100,000,000 more during what is known as the Second Red Cross War Fund Week, May 20-27.

But with each call for funds the question naturally arises as to where these millions go, and since twenty-two million members have a right to know how their money is being spent, the following gives in brief what the first War Fund has been appropriated for up until Mar. 1, 1918.

FRANCE, $30,936,103.04

Established infirmaries and rest stations along all routes followed by the American troops in France.

Built canteens for use of French and American soldiers at the front, also at railroad junctions and in Paris.

Supplied American troops with comfort kits and sent them Christmas gifts.

Established a hospital distributing service that supplies 3423 French military hospitals and a surgical dressing service that supplies 2000.

Provided an artificial-limb factory and special plants for the manufacture of splints and nitrous oxide gas.

Established a casualty service for gathering information in regard to wounded and missing.

Opened a children's refuge hospital in the war zone and established a medical center and traveling dispensary to accommodate 1200 children in the reconquered sections of France. Fifty thousand children throughout France are being cared for in some measure by the Red Cross.

Planned extensive reclamation work in the invaded sections of France from which the enemy has been driven; this work now being carried out with the coöperation of the Society of Friends and an alumni unit from Smith College.

Established a large central warehouse in Paris and numerous distribution warehouses at important points from the sea to the Swiss border for storing hospital supplies, food, soldiers' comforts, tobacco, blankets, clothing, beds and other articles of relief.

Secured and operate 400 motor vehicles for the distribution of supplies.

Opened a hospital and convalescent home for the repatrie children at Evian; also established an ambulance service for the adult repatries who are now returning from points within the German lines at the rate of 1000 a day.

Organized a nurses' service for American Army use.

Established twenty dispensaries in the American Army zone to improve health conditions in that section before the coming of American troops.

BELGIUM, $2,086,131

Erected warehouses and stores to serve as centers of relief distribution.

Started reconstruction work in reconquered territory, supplying repatriates with temporary dwellings, tools, furniture, farm animals and supplies essential to giving them a fresh start in life.

Appropriated $600,000 for the relief of Belgian children, covering their removal from territories under bombardment and the establishment and maintenance of them in colonies.

Provided funds for the operation of a hospital for wounded Belgian soldiers and for part of the equipment of a typhoid hospital.

ITALY, $3,588,826

Provided the Italian Army with three complete motor-ambulance sections comprising sixty ambulances, forty trucks and 100 American drivers.

Contracted for 10 field hospitals complete for use by the Sanita Militaire and the Italian Red Cross.

Supplied 1,000,000 surgical dressings. Opened relief headquarters in nine regional districts of Italy.

Established a hospital for refugees at Rimini.

Planned and made appropriations for extensive work among the refugees in all parts of Italy.

RUMANIA, $2,676,369

Rushed more than $100,000 worth of medical supplies and foodstuffs into Rumania immediately after the retreat to Jassy.

Carried general relief work into every part of the stricken country not invaded by the Teuton and Bulgarian forces.

UNITED STATES, $8,589,899

Organized and trained 45 ambulance companies, totaling 5580 men, for service with American soldiers and sailors.

Built and maintained four laboratory cars for emergency use in stamping out epidemics at cantonments and training camps.

Started work of eradicating unsanitary conditions in the zones immediately surrounding the cantonments.

Established camp-service bureaus to look out for comfort and welfare of soldiers in training.

Supplied two million sweaters to soldiers and sailors.

Mobilized 14,000 trained nurses for care of our men.

Established a department of Home Service and opened training schools for home service workers.

Planned convalescent houses at all cantonments and training camps. Increased membership from a scant half million to approximately 22,000,000.

OTHER DISBURSEMENTS

For War Relief in other countries, including Great Britain, Russia and Serbia, $7,581,075.

To supply food to American prisoners in Germany, $343,-304.

For supplies purchased for shipment abroad and for advances to chapters for material, $15,000,000.

Equipment and expenses in United States of personnel for Europe, $113,800.

Restricted as to use by donors, $2,500,410.

Working cash advanced for France and United States, $4,286,000.

Making a grand total of approximately $78,000,000.

To those who care to study the details of how each penny has been spent, printed statements covering all War Fund appropriations are obtainable from Chapter chairmen.

The foregoing covers some of the principal battle grounds in the Red Cross War against want and misery, but other millions are being constantly appropriated to meet new needs as they arise, and the War Fund must be replenished, for it is inconceivable that such work should ever be allowed to suffer for the lack of mere money.

Give to your Red Cross until your heart says stop—it is the Heart of the World.

*Compiled from American Red Cross Reports.

Editorials

How About Next Winter?

IF REPORTS are any indication, the coal situation is far from satisfactory. To say the least, conditions are anything but reassuring, and the possibilities of experiencing a fuel shortage during the coming winter, as we did last, have not by any means been entirely removed. The Fuel Administration has been putting into effect very elaborate and no doubt effective plans and probably is doing all that is possible to meet the emergency so far as getting coal out of the mines and delivering it to the consumer. However, there is another side to the question—how the coal is utilized after being delivered to the consumer—and this is just as important to think about just now as the delivery of the coal, since every ton saved during the summer is a ton available next winter.

Almost simultaneously with an announcement that the coal situation was critical, the restriction on the use of advertising illumination was removed. Would it not have been more in keeping with the seriousness of the fuel problem to have continued the restrictions until such times as we might look forward with some feeling of certainty that coal would be forthcoming next winter, when it is an absolute necessity to human existence in cold climates?

Preston S. Millar, in a paper presented before the Illuminating Engineering Society in New York City, February 15, pointed out that the net coal saving thought desirable through curtailment of lighting was equivalent to seven per cent. of twelve million tons used for the production of light by electricity, or eight hundred and forty thousand tons. The author expresses the opinion that the saving possible through the curtailment of light is so small compared with the coal saving possible by other adjustment as to make that obtained by the curtailment of lighting of little consequence.

However, we must not overlook the fact that this saving is obtained after increasing industrial lighting fifty per cent. above the standard at that time, and increasing protective lighting two hundred per cent. If industrial lighting had not been increased as suggested by Mr. Millar, but maintained at its present standard, it would have made possible a total saving of approximately sixteen per cent., or two million tons of coal per year. But allowing that it is possible to save only eight hundred and forty thousand tons per year by lighting curtailment, this is something more than an insignificant item. If this amount of additional coal had been available last winter and had been used for heating homes, at least eight hundred and forty thousand families could have been kept warm for a month. Or if used for industrial lighting and power purposes, many of the industries that were forced to shut down or curtail their output for considerable periods last winter could have run at full capacity.

The fact that if each family in this country would decrease by one shovelful its daily use of coal the result would be an annual saving of fifteen million tons looks simple at first thought, but we must not overlook the fact that last winter tens of thousands of families in this country did not have the one shovelful to save and would have been only too glad to have had some of the six hundred thousand tons used for advertising illumination.

Let us not forget that there is another winter not very far ahead of us, and that all the time the demands for light and power in industries essential to the winning of the war are increasing. If the high rate of production that these industries have been establishing this last month or so is to be kept up the year around, it is absolutely necessary that they have an uninterrupted coal supply for light, heat and power and that the employees have comfortable homes during the cold season as well as in the summer. Until it is absolutely certain that the coal supply is adequate to meet this demand, it would seem that we can do with somewhat dimmed white ways, which have become a part of our city life.

Pseudo Data

C. E. STROMEYER is reported in *Engineering* to have said during discussion of a meeting of the Institute of Mechanical Engineers, London, that personally he disliked associating boiler insurance with boiler inspection. As an instance of how insurance worked, he stated that in America there was no association which corresponded to those in England whose first duty is to inspect. The American boiler-insurance companies he said, published at intervals a leaflet giving the number of boiler explosions, the standard being the number of deaths caused. In England, for insured and inspected boilers, there were ten deaths per annum as against two hundred in America. That illustrated the significance of inspection.

As reported, the figures are significant of nothing. We do not question but that per unit number of boilers in service, we in America have more boiler explosions than occur in England. The excellent supervision by the Board of Trade and the service to members by the Manchester Steam Users' Association, for which Mr. Stromeyer is chief engineer, are influential factors in preventing boiler accidents. But data, or more correctly, perhaps, statistics, given or reported in such loose manner were better unsaid. The reader or listener should know what is considered as an explosion, what relation the terms of the ratio 10: 200 deaths per annum bears to the total number of boilers installed or in service in the two countries respectively.

The trend of business makes it increasingly important that engineering data be comprehensible as well as exact. This applies not only to such cases as the one cited, which is used merely as an example, but to data in general, and especially those presented in society papers. No national good can come of giving informa-

tion that is subtle and that is used to achieve victory in argumentation for some proposals or practice regardless of their engineering truth either as pure science or as related to other conditions necessary to their industrial application.

Pseudo facts may well be used by lawyers (though by every consideration of justice and honesty they should not be); but these are wrong in engineering—wrong ethically and socially. In his most interesting book, "The Great News," which contains so many captivating phrases, but which one may gently criticize as a little too intangible, Charles Ferguson has a statement that applies well here, namely: " . . . there is absolutely no social will-power directed to the upkeep and improvement of the apparatus of civilization." The point is that each of us is too much concerned about making good our particular case, however much harm may be done or confusion created broadly.

The Golden Rule must be dragged out of a musty book, sincerely embraced and frankly applied by the professions and the trades—not in parlor discussions and philanthropical endeavors alone, but all during the working day. It must dull the narrow, personal and selfish conscience and stimulate the broad, national conscience to which the war's hardships and magnitude have given new life. Certainly the great blessing of the war will be the honest, altruistic coöperation and coördination of the forces of civilization to make the world a better place to live in. When each nation, bleeding, hungry and poor, emerges from the long struggle and turns to look over its shoulder at the fields and seas where lie its young and honored dead, it will resolve that nevermore shall science be the handmaid of holocaust; but rather that it shall serve the peaceful arts so well that the incentive which gives birth to wars will starve into extinction. To even make a good beginning, facts must be presented so as to be exposed top, bottom and all sides.

Looking Ahead

FROM coal heaver to general manager seems a long uphill climb—a journey that many begin and few finish—yet it is supprising how quickly some make the trip. It seems but yesterday that they were heaving coal and sweeping tubes, yet ten years have slipped by, and today they are directing the management of the whole plant and ever planning for improved conditions and greater things. These men kept their eyes front. By this it is not meant that they dared not glance sideways, but that they had a fixed goal—a beacon ahead upon which they kept their eyes fixed in order to steer the course that they knew would shorten their trip to that harbor of Success. These fellows were never afraid to tackle a job, no matter how much energy it required. To be sure, they must have had times when they questioned themselves as to whether they were capable of doing it—this is just what gave them confidence.

Never before in the history of this great nation has there been such a demand for men who can handle big tasks. Some of the ablest men in the field have gone to Washington and into the service of the country. Their posts in the plant had to be filled by their trained subordinates, which in turn meant a general shake-up all through the various grades in the plant, and those who were capable and ready were boosted up a step—sometimes two.

Our great merchant marine is incessantly calling for engineers with ability and courage; already it has made large inroads on the staffs of the power plants throughout the country.

Great shops and industrial centers have developed with astounding rapidity. One stops to wonder where they got the men with ability to fill the many positions of responsibility. It does not require much study to find where they came from. They were ready to answer the call—up from the ranks to take command. They were men who had faith in their ability to develop themselves by study and increasing work. Where are you in this great change that is being wrought? Surely, you cannot be still thinking that there is no show—no opening for you—no chance to get into a better job. The only bid you can make for that better job is to outgrow your present one.

You would not now be reading this article if all your ambition were dead. You would not have this magazine in your hands if you were not trying to find something that would help you. Men don't read technical papers for pastime—they do it to keep informed and to better themselves.

The Coal-Zoning Plan

THE importance of an adequate coal supply in the winning of the war cannot be minimized or ignored. Decreased or interrupted production may result in stoppage of industries engaged on war contracts, the enforced idleness of labor, and eventually a condition similar to that of last winter, when thousands of homes found themselves without heat.

The zone system of coal distribution put into effect by the order of the United States Fuel Administration represents a serious and at the same time an ambitious attempt to cope with the difficulties of the fuel situation. It is not the outcome of ill-advised haste or snap judgment, but rather a plan resulting from months of study and careful consideration.

It would be futile to expect that a scheme so far-reaching in its scope could be put into effect without some disruption of established relations. The urgent necessity for diminishing the burden on transportation facilities involved restrictions and prohibitions that had previously been unknown; but wherever it could be done, long-established trade relations were preserved, since this would reduce the confusion and disorganization attendant upon the adoption of the new plan.

So many interests must be considered in the working out of a successful scheme of fuel regulation that the situation is exceedingly complex, and so it becomes necessary to provide for a certain measure of flexibility in order to meet changing conditions and unforeseen emergencies. This has been done by providing for a system of special permits to be issued by the Fuel Administration whenever circumstances warrant. Thus, while the zone system as announced may show faults and imperfections as it comes to be more widely applied, the special-permit provision makes possible a prompt adjustment to prevent injustice or unnecessary hardships.

Correspondence

Second-Hand Boilers in Bad Shape

A few months ago I took charge of a plant where they were installing a second-hand Scotch marine boiler that had been purchased by the general manager from a second-hand dealer who represented that it had been inspected by a state and also by an insurance inspector and passed to carry 110 lb. pressure. I made a thorough inspection of it and found things in good condition until I crawled into the combustion chamber, and there I saw a sight.

The ends were burned off from about three-fourths of the tubes, and some of them were so badly corroded that they only stuck halfway through the tube sheet. The leakage had been so bad that sediment almost choked up some of the tube ends. How inspectors could have passed the boiler if they inspected it at all, and I don't believe they did, is more than I can say. We had to remove the tubes, have ends welded on, and replace them again before the boiler was fit for service. This cost the company about two hundred dollars besides the trouble and delay in getting the boiler into service. It is in good condition now and giving satisfactory service, but the incident goes to show that it is mighty dangerous and expensive for a man without practical knowledge of boilers to buy second-hand ones without having a thorough inspection made. S. A. REILLY.

Orrville, Ohio.

Saving Ammonia and Coal

Nearly all engineers know that they should not try to save ammonia by not putting in the proper charge at the beginning of the season. One can make up for a weak or insufficient charge only at the expense of the coal pile. This applies to absorption machines particularly. They are commonly run with insufficient ammonia, as it is so easy to get the capacity by circulating a little more weak liquor per pound of anhydrous needed to do the refrigerating.

This is bad practice. The weight of weak liquor circulated per pound of anhydrous should be kept as low as possible, say 6 to 7 lb.; 12 or 14 lb. is not unusual in some plants.

The speed of the aqua pump should be as steady as possible. Most manufacturers furnish a regulator to care for this pump.

With coil absorbers with the separate mixer on each coil there is a tendency for the liquid to "dump" or come in irregularly. When this happens, there occurs a loss due to not having the strong liquor from the pump to the generator at as high a temperature as it would have if it had passed in a steady flow through the exchanger and analyzer. The flow of weak liquor from the generator through the exchanger is almost constant, and for the exchanger to heat the strong liquor as much as possible and cool the weak liquor also, both must pass in a steady flow.

Although machines fitted with this type of absorber have a large aqua receiver which helps to take care of irregularities, the men will often give the pump too much steam, causing too fast a flow of liquid. Where such conditions obtain, I would disconnect the regulator and let the men control the pump by hand; they will soon get it set so it will not stop and race.

I know of one plant where the irregular speed of the aqua pump caused the temperature of the exchanger to vary so that one of the head gaskets blew out, with a loss of some ammonia and loss of the machine for four days during the summer's rush. Keep the pump operating steadily and watch the liquid seal on the ammonia receiver so as not to blow any gas over in the cooler or ice tank. Every pound of gas carries with it the latent heat plus the superheat.

Keep the strong-liquor pump rod packed so as not to leak ammonia out and air into the system and you will have little trouble with non-condensable gases, which always cause some loss of ammonia when purging.

Make it a rule when you go on watch to look things over, then take your sulphur stick and examine the machines for leaks, for many small leaks will go unnoticed if one depends only on one's nose to find them, especially if coils are located on the roof.

Machines with double-pipe or submerged cooling coils, where the ammonia from a leak will be absorbed by the water or brine, make it necessary to test this brine and water with Nessler's reagent. This should be done at least three times a week.

The formula for making Nessler's reagent was published in the Jan. 15, 1918, issue of *Power* and may be found in most handbooks on refrigeration. Sensitive paper is useful for locating leaks on the water side of the machine, but cannot be depended upon in calcium brine, as such brine turns the paper red whether the brine does or does not contain ammonia.

Jersey City, N. J. BERNARD LAMB.

Horseshoe Magnet a Handy Tool

The suggestion, by W. H. Bennett, page 447 in the issue of Mar. 26, for removing drill chips is a good one. I have also found that a horseshoe magnet, one taken out of an old house telephone for instance, is mighty useful for the same—and many other purposes. If the magnet is too large to go into the hole, it can be put in contact with a small rod as an extension or the rod can easily be magnetized if near a plant that has magnetizing coils.

Two or three magnets tied together will be found useful to wiremen when a knife, screwdriver, pliers or other tool is accidentally dropped down an open partition as sometimes happens. Just lower the magnet on a string until it comes in contact with the tool, then "haul away." R. L. PETERSON.

Knoxville, Iowa.

Home-Made Pipe and Drilling Vise

A handy pipe vise that can be made by any engineer who is not in a position to purchase one is shown in the accompanying illustrations. The grip on pipes should be, as much as possible, around the entire cylindrical surface, otherwise the pipe is easily scored. The device described was built in three sizes. The largest size, fitted with brass jaws, is used for gripping small pipe or rods for various light operations. When mounted on a block, Fig. 2, it serves as a handy vise for drilling round stock. It can be attached directly to the bench, Fig. 1, or gripped in the vise, Fig. 3, for threading, or clamped to a drill-press bed for drilling holes in round stock, Fig. 4. The vise is composed of two plates. Plate *A*, Fig. 1, is made of angle iron for fastening to a block or bench; *B* is of steel plate of the same length and can be used for fastening to a bench or for being gripped between the jaws of a bench vise. Both pieces are reinforced on the upper edge by a piece of steel, *C*, riveted on. In the center of these assembled plates a V-shaped way is sawed, which is provided with fine teeth for gripping purposes. The movable jaw *D* is made from a U-shaped strap, in the center of which is riveted a solid block *E*. This upper jaw is guided between the two lower jaws by means of a bolt pivoted between them, as shown. A handle nut is also provided for quick action in opening or closing.

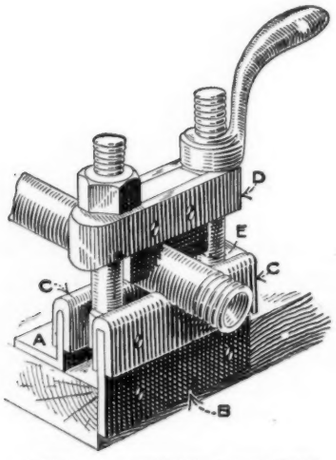


FIG. 1. DETAILS OF CONSTRUCTION

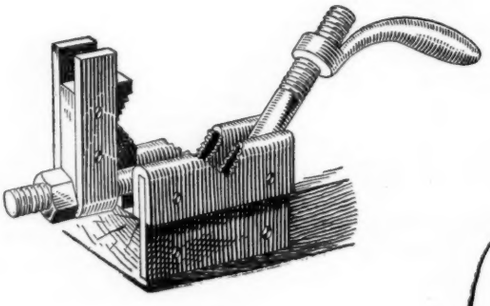


FIG. 2. VISE SHOWN IN THE OPEN POSITION

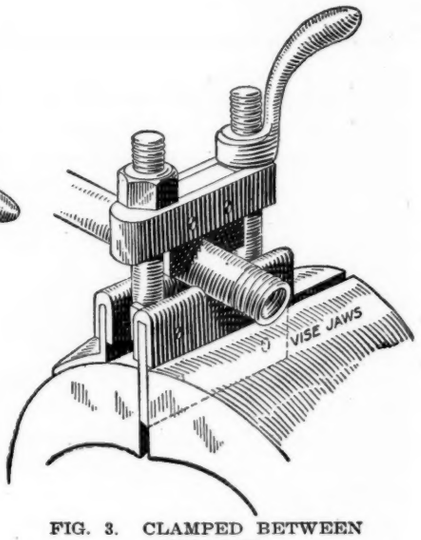


FIG. 3. CLAMPED BETWEEN VISE JAWS

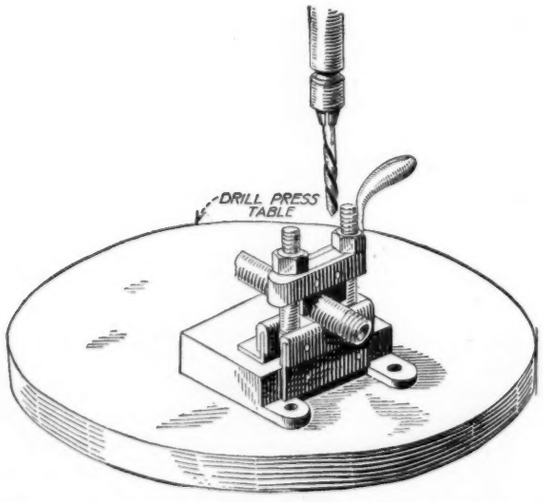


FIG. 4. VISE CLAMPED TO DRILL-PRESS BED

New York City. J. A. LUCAS.

Burning Fuel Oil

Why do we not get more articles on the subject of burning crude oil? Plants in both Texas and California are large users of fuel oil, and in a great many small plants it is burned very inefficiently. Engineers of large plants are beginning to realize that large combustion chambers give the best results, and when setting new boilers, raise them from two to three feet higher than the old-style setting. The bridge-wall is placed about ten feet back from the doors, and the grates are covered with loose firebrick. Most of the air should be admitted under and on each side of the burner, with just enough admitted under the flame to raise it away from the grate and keep the grate cool.

As every engineer knows, an excess of air means a loss in economy and all brickwork is more or less leaky. By using the damper to control the air supply, the difference in pressure between the inside and outside of the setting can be kept at the lowest point.

With from 3½ to 4 sq.in. of clear air space through the grates for each normal horsepower rating, a draft from 0.05 to 0.1 in. of water next to the damper is sufficient to give air enough to carry better than normal rating on the boiler, and certainly there won't be as much air leakage as when the ashpit doors are used to control the air supply and a difference of from 0.3 to 0.4 in. is maintained between the inside and outside by leaving the damper wide open. L. D. HARRIS.

Houston, Tex.

[We welcome and pay well for contributions, articles and letters on the subject of oil burning—as well as on all subjects of value to power-plant engineers and others interested in the generation and distribution of power. —Editor.]

Fires in Turbo-Generators

M. A. Walker's article on "Fires in Turbo-Generators," in *Power*, issue of Jan. 22, is, I believe, a live subject and one worthy of serious consideration. As Mr. Walker points out, the modern turbo-generator contains material that will burn and, once ignited, makes a difficult fire to fight on account of its location and the great amount of blinding and suffocating smoke given off.

My experience has convinced me that one of the best preventives of these fires is to get the machine off the line and kill the field at the first sign of trouble. I have seen four or five cases where doing this prevented a fire, and others where it was not done caused serious fires, totally destroying the insulation on the ends of the stator coils, besides damaging the tie rings and laminations.

The first cases that came under my observation were on 4500-kv.-a. 13,200-volt three-phase 60-cycle machines. On the first machine to give trouble, the insulation broke down on the top coil in a slot, and burned this coil off, damaging the insulation of the bottom coil and the top coil in an adjacent slot. These three coils had to be taken out; two were reinsulated on the job and put back, and a third had to be replaced by a new coil. In three other cases in this plant we lost from one to three coils in like manner, all of these breakdowns being near the center of the slot length.

Practically all these burnouts were preceded by line trouble causing a heavy surge, and as there were no reactances in the line, the generators received the whole strain. The first indication of trouble would be a groan from the generator, then a few sparks mixed with dust. As these machines had an air outlet on top that was easily seen by the switchboard operator, he generally discovered the trouble when it first started and cleared the machine.

In one case there was a new operator on the board; two machines were in parallel when the trouble started. The switchboard attendant tried to prevent interrupting the load by holding the defective unit on the line until the engineer brought another machine up to speed. The result was that both coils in one slot were completely burned out, copper and all, and the insulation at each end of the winding was set on fire.

These generators had small plates near the top of each end bell, giving access to the inside of the machine. Although these covers got almost red-hot, we succeeded in removing them and in a short period had the fire out by the use of two ¾-in. water hose—but not before the insulation was entirely ruined on both ends of the winding, and the tie rings, which were wood, were also consumed. The arc in the slot welded the laminations together so that the stator core had to be taken down and the iron restacked, and between three and four tons of laminations replaced by new stock.

Two other cases that came under my notice were of 5000-kw. vertical units which burned out within ten minutes of each other. The cooling air for these units was drawn in at the top of the housing and discharged at the bottom, on top of the turbine casing. This made it very difficult to get at the fire. In one unit the burnout occurred right over the side where the throttle valve was located, so that the operating crew could not get to it to shut the steam off. The melted copper, iron, etc., from the burnt-off coils clogged the valve gear in the open position so that things were in excellent shape for a speed wreck, but fortunately the flame was so intense that it melted off the trip rod, from the emergency governor, thus releasing the throttle and allowing it to close.

These were old units which had seen hard service and, at the time they failed, were carrying heavy loads on account of another larger unit being out of service owing to a similar burnout. This latter unit failed at the end of a slot, doing some damage to the laminations as well as burning the ends of the coil on that end of the winding.

Another burnout that comes to mind was that of a large machine in which the trouble started at the end of one slot. The first indications of trouble were a few sparks for a short time before the actual burnout, which took the form of an explosion, shooting flame and smoke out of the air outlet on top of the generator. It required over two hours to put this fire out. In this instance the laminations were not injured, but all the coils were damaged and most of the tie rings were burned or cracked so that they had to be replaced. I believe that if this generator had been cut out at the first sign of fire, the trouble would have been localized and only one or possibly two coils damaged.

From these experiences I believe the surest way to localize the trouble is to kill the machine at the first sign of sparks or smoke. This may cause a shutdown for a short time, but that is better than burning out a machine, putting it out of service from two to eight weeks, depending on its size and the extent of the damage; besides, the cost of repairs may easily run up to several thousand dollars on large units.

Mr. Walker's suggestion for fire-fighting inlets or connections is an excellent one and should be adopted for all units. It appears to me that an effective scheme could be worked out by placing a ring of pipe around the ends of the stator just back of where the coils leave the slots, or in any suitable location where there is room, with sprinkler heads, such as are used with automatic sprinkler systems, at intervals of six or eight inches along the pipe so that they point in toward the coils; the melting point of the head to be, say, 50 deg. F. above the maximum allowable temperature of the generator, and the pipe line to be carried outside of the generator to a valve and connected to the water supply. There should be a drain opening between this valve and the sprinkler ring, which should be kept open so that any leakage of the main valve may be detected.

The pressure should not be kept on the sprinkler system all the time, as something might cause it to leak and damage the generator. In case there was a burnout or the attendant saw sparks or smoke coming from the generator, he could turn the water into the sprinkler system. If there was a fire at any point, one or more of the heads would be open and the water would be played on that point and not all over the machine as from a hose. If there was no fire serious enough to open the sprinkler heads, no water would reach the windings to cause damage. If the fire tended to spread around the armature, additional heads would open up to extinguish it.

This system could also be used in connection with

carbon tetrachloride or carbon dioxide, as suggested by Mr. Walker, for fighting these fires, by connecting the system to tanks containing these chemicals under suitable pressure, instead of to a water supply. When using these chemicals, smaller-sized piping could be used to advantage.

I do not know whether this scheme has ever been used, but I see no reason why it would not work out satisfactorily, and the cost of installing the apparatus would be little compared to the expense of rebuilding a generator and the loss of service during the repairing.

The use of shutoff doors or dampers in the air inlets and outlets to the generator is another important detail, since with a turbo-generator with the field open, there is from a quarter of an hour to an hour in which the rotor will be turning and forcing air through the generator if these openings are not closed. These dampers should be controlled from the floor, where the engineer could reach them without leaving the throttle of the turbine. They should not be automatic in operation.

All of us who are in the business are interested in this subject, and I feel that it is very important to do what we can to help prevent these fires. They are not only a loss in profits to our companies, but are a waste, and at this time it behooves all of us to prevent such waste, whether of fuel, food, labor or material.

Claymont, Del. EVERETT PALMER.

Reusing a Cotter-Pin

The next time you try to replace a used cotter-pin that is spread at the end (as shown in the illustration at *A*), instead of trying to hammer the ends together, which cannot be done, try kink *B*. This produces a cotter of

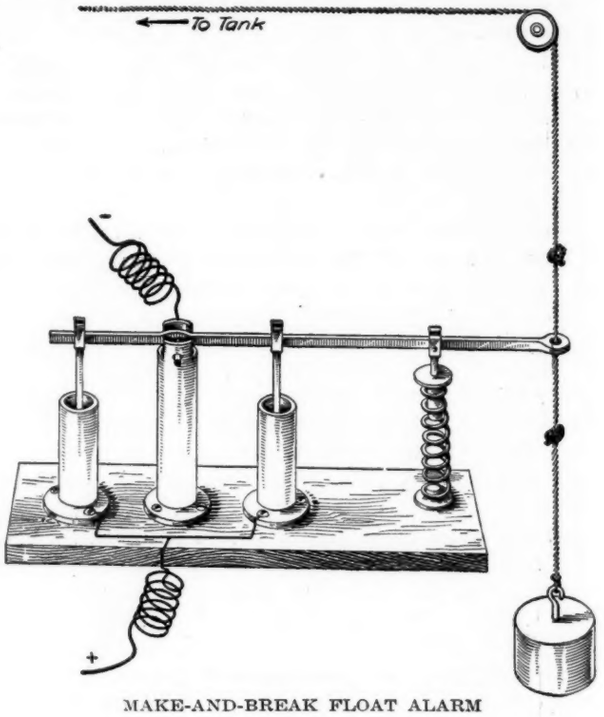
MAKING A COTTER PIN EASY TO ENTER

the shape shown at *C*, which is easily reëntered. This is a simple kink, and no doubt many readers will say, "Any fool oughter know that," but it has come to my notice that a lot of wiseheads do not make use of it, so I am passing it along. C. H. WILLEY.

Concord, N. H.

High and Low Water Alarm

I have made a successful high and low water alarm out of a couple of dashpots taken from old arc lamps and partly filled with mercury. A lever is pivoted, as shown in the illustration, so that when the long end is depressed or elevated by a knot on the float-cord passing through the eye at the end, contact will be made between the points on the lever and the mercury, com-



MAKE-AND-BREAK FLOAT ALARM

pleting the electric circuit, which lights a pilot lamp or rings a bell. The lever is held in a central or neutral position by the coiled spring until one of the knots forces it one way or the other, and the difference in the water level in the tank before an alarm is given depends on the distance between the knots.

Paxton, Ill. S. R. RODGERS.

Pump Strokes Irregular

In the plant where I am employed one 5½ x 3½ x 5-in. Worthington boiler-feed pump began giving trouble on one side. The right side would make the stroke all right, but the left would jerk and pound. At first I tried adjusting the valves, but this did no good, so I took the head off the water end and found that the night engineer in repacking the right side had put in four rings of packing instead of three, causing more friction on that side. So I added one ring to the left side and the trouble stopped.

The 14-in. by 30-ft. leather belt from a 75-hp. motor to an air compressor had been burned on one side, causing that side to stretch, and it flapped every time that part went over the motor pulley. I turned the belt over and the noise and disagreeable flapping stopped.

Provo, Utah. O. W. MANN.

Six new authorized United States battleships are designed to be of 41,500 tons, the largest battleships in the world.

Inquiries of General Interest

Use of Piston Valves on Compound Engines—For compound engines, why are piston valves frequently used for the high-pressure and flat slide valves used for the low-pressure cylinders? D. L.

For the high-pressure side, piston valves are preferable because they can be balanced and operated with little friction, and although repairs for making this type of valve steam-tight are more difficult than repairs to flat valves, tightness against valve leakage is of less importance on the high-pressure than on the low-pressure side of the engine.

Trapping Returns Discharged Below Boiler—Our heating system is supplied with steam at reduced pressure from boilers that carry high-pressure steam for power purposes. The returns from the heating system must be discharged about 10 ft. below the boiler. How can the return water be trapped to the boiler? J. E. H.

Place a return trap below the returns of the heating system and have this trap discharge to another return trap placed above the boiler for returning the condensate to the boiler. The most rapid operation will be obtained for the purpose by employing return traps whose receivers are vented to the atmosphere while filling.

Water-Hammer in Pump Suction Line—How can water-hammer be prevented in a pump suction pipe? A. H.

Water-hammer results from sudden checking of the velocity of the water at each reversal of the pump. It can be prevented by connecting an air chamber to the pump suction pipe in such a manner that when the column of water is stopped or checked by action of the pump, the direction of flow may continue past the pump suction chamber or valves to the air chamber. The energy of the moving column of water can thus be expended directly on the confined air; but an air chamber will be of little benefit if connected to the side or top of the suction pipe so the water passes under or at right angles to its connection.

Intrinsic or Internal Energy of Steam—What is the difference in signification of the terms total heat, intrinsic energy, internal energy and intrinsic heat of steam? A. D. B.

The term "total heat of steam" in any given state is understood to mean the amount of heat required to heat at constant pressure, a unit weight of water from the temperature of melting ice to the state under consideration. During the period of vaporization the volume of a pound of water is changed to the much larger volume of steam and the external work done in order to reach the state of the steam is called the "constant pressure external work." The terms intrinsic energy, internal energy and intrinsic heat are each used to signify the same thing, meaning the heat energy contained within the steam above 32 deg. F., and it is equal to the total heat less the constant-pressure external work.

Delta-Connected Transformer Banks Connected in Parallel—Would there be any objection to connecting two transformer banks in parallel, each bank being grouped in delta on both the primary and secondary? One bank consists of three 75-kw. units and the other bank of three 100-kw. units. D. C. A.

It would not be considered good practice to parallel two banks of transformers of different capacity such as indicated in the question. The chief objection to this practice is the difficulty that would be experienced to get the load to divide in the proper proportions between the two banks. To a certain extent this difficulty could be taken care of by connecting a resistance in series with the leads of the bank that has a tendency to take more than its share of the load. Even if the banks were the same capacity, it would not be good practice to operate them in parallel. If possible, each bank should supply a separate load.

Taking Gas- or Oil-Engine Suction-Stroke Diagrams—Diagrams made with the ordinary stiff spring necessary for use for indicating gas and oil engines afford little information of the action of the valves during the suction stroke. How can appropriate diagrams be obtained? A. E. R.

The events in the suction stroke must be obtained separately with a weak spring in the indicator. The spring should be protected from excessive pressure of the explosion stroke by inserting a suitable stop to prevent undue compression of the spring. For that purpose a distance piece may be made of a small brass tube slipped over the piston rod of the indicator or, for an indicator with an inside spring, the distance piece may consist of a thin brass tube that will freely pass over the outside of the spring and inside of the indicator cylinder while resting on the top of the piston.

Scale-Forming Impurities in Feed Waters—What are the usual scale-forming impurities in boiler feed waters? C. N. D.

Those most often present and in largest quantities are:

Calcium carbonate (lime), chemical formula	$CaCO_3$
Magnesium carbonate, chemical formula	$MgCO_3$
Calcium sulphate, chemical formula	$CaSO_4$
Magnesium sulphate, chemical formula	$MgSO_4$

The impurities less frequently found and usually in small amounts are:

Iron carbonate, chemical formula	Fe_2CO_3
Calcium chloride, chemical formula	$CaCl_2$
Magnesium chloride, chemical formula	$MgCl_2$
Potassium chloride, chemical formula	KCl
Sodium chloride, chemical formula	$NaCl$

Some iron oxides, calcium phosphate, silica and organic matter also may be found, though usually in small quantities.

Effect of Clearance on Air Compressor—What effect has cylinder clearance on the capacity and power required by an air compressor? S. E. M.

In single-stage compression, clearance reduces the volumetric efficiency or ratio of the volume of free air, actually admitted and compressed in the intake cylinder, to the volume of piston displacement. The percentage in reduction of capacity is greater than the percentage of cylinder clearance, as the piston must travel back a larger percentage of the return stroke before the air previously compressed into the clearance spaces has expanded to atmospheric pressure, permitting the free air supply to flow into the cylinder. Since the volume which the expanded clearance air occupies increases as the pressure increases, the loss in capacity by clearance is directly proportional to the pressure. The loss of volumetric efficiency due to clearance is less for two-stage than for single-stage compression because, for given capacity, the low-pressure cylinder of two-stage compressors is practically of the same size and has the same percentage of clearance as the cylinder of a single-stage compressor, and the terminal pressure of the two-stage machine is much lower with less expansion of the compressed clearance air back into the cylinder volume. The work required for compressing the clearance air to receiver pressure in expanding back to atmospheric pressure helps to move the piston on the return stroke and as the loss of heat during expansion is negligible there is practically no loss of power from clearance excepting that its presence increases the size of compressor required to deliver a stated amount of air, thereby requiring more power for its operation.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Notes on the Operation of Submarine Diesel Engines*

By LIEUT. F. C. SHERMAN, U.S.N.

The following notes have been made as the result of practical experience in operating submarine Diesel engines of the two-stroke-cycle Nürnberg type of New London Ship and Engine Co. manufacture. They are particularly applicable to that engine, but it is felt that some of the ideas evolved may be adaptable to engines of other types when similar troubles have been experienced.

In spite of the widespread reports of unreliability of submarine Diesel engines of the past few years, the writer has always maintained that every effort should be made to make the material operate satisfactorily before condemning it as unsatisfactory and unreliable. In many cases further investigation has shown that inexperienced personnel are to blame and not the long-suffering and almost always blamed material.

In the type of engine upon which this discussion is based, the crank case is totally inclosed and the oil from the lubricating system, after cooling the piston heads, is drained into the crank case, from which it runs into the settling tank and is used over again. The scavenger air for the working cylinders is compressed in a scavenger cylinder in tandem with the working cylinder, and the piston is of the stepped type, the lower step working in the scavenger cylinder and compressing the scavenger air which is forced into a housing around the scavenger cylinder and above the crank case. The scavenger cylinder makes a joint between the crank case and the scavenger housing.

Crank-Case Explosions

Now, in every case of crank-case explosions it was found that there was a leak from the scavenger housing to the crank case. This joint was packed with soft packing and proved to be very difficult to keep tight, due to the scavenger cylinder holding-down bolts working loose from continual shock. But in every case of crank-case explosion, a leak of scavenger air to the crank case was found, and when it was corrected the explosions stopped. The permanent care taken following this discovery was to test the scavenger housing at frequent intervals for tightness with air pressure and to examine frequently the scavenger cylinder holding-down bolts and to keep them set up tight every time they came loose. These tests were made about once a month, and following this care, practically all crank-case explosions and their destructive results were eliminated.

Another remedy adopted, not as a cure but to reduce the effect of a crank-case explosion, was to install a vent to the crank case. The crank case is totally inclosed only to retain the oil used in the lubricating system and prevent its being splashed about in the engine room. The result was that when a crank-case explosion occurred the gas had no place to escape without wrecking something, blowing off the crank-case doors or housing. To prevent this, a 2½-in. pipe was led from one end of the crank-case housing and left entirely open. The main purpose of the pipe was to furnish an opening to the crank case to allow the expanding gases of the explosion to get out without blowing something out.

Another feature of the leak in the scavenger housing was found to be that the scavenger-housing temperature increased unduly, especially when running at higher powers. This undue rise of temperature probably resulted from slight burning of the oil vapor around the leak causing an increase of the temperature without, however, causing an explosion. A correction of the air leak always resulted in a decrease of scavenger-housing temperatures. These leaks from the scavenger housing, it must be understood, were not sufficient to cause trouble from drop in scavenger-air pressure and would ordinarily not be expected to give any trouble.

Closely allied with the crank-case explosions, but of an entirely different nature, were scavenger-housing explosions. These were found to be due to two causes; namely, presence of a superfluity of oil in scavenger housing and leaky or defective scavenger valves. If there was too much oil in the scavenger air and the scavenger valve to the working cylinder remained open an instant too long or leaked after it was closed, the compression temperature or flame from the working cylinder would be transmitted to the scavenger housing and set off the oil and vapor in that chamber, resulting in an explosion liable to wreck the housing, as relief valves fitted there were never efficient in quickly releasing the excessive pressure formed. The remedy for this form of explosion was to keep excessive oil out of the scavenger housing through drains fitted at the bottom and to keep the scavenger valves to the working cylinders functioning properly.

Piston and Cylinder Troubles

Cracked piston heads, cracked cylinders, cracked pistons and piston seizures are almost all traceable to defective cooling of the piston head. On the particular type of engine in question, the pistons were cooled by lubricating oil forced up from the lubricating system through the connecting-rod and wristpin and then up through a pipe leading to the hollow piston head and thence down on the opposite side through a drain pipe to the crank case, whence it drains by gravity to the settling tanks.

The most frequent cause of defective cooling of the piston heads was the presence of salt water in the lubricating oil which remained in the piston head owing to the location of cooling-water inlet and outlet. Due to the temperature to which the oil was subjected, the water would quickly evaporate, leaving a salt deposit in the oil which was black in color, giving the appearance of carbon. For a long time this deposit was thought to be carbon, on account of its color, but an analysis showed it to be over 90 per cent. salt. This salt would form a black, gummy mass and would soon collect in the piston heads and the pipes leading to them and result in decreasing or blocking altogether the supply of cooling oil to the piston heads, which would instantaneously get hot and either crack or seize, or heat would travel to the cylinder or piston itself, resulting in cracking the cylinder with its cooling water outside or the piston seizing and cracking.

Obviously, the remedy for this is to keep salt water out of the oil. However, with an engine using salt water for its cylinder-cooling and oil-cooling medium, this is not as easy to do as it sounds; but it can be done if proper care is exercised. On the vessel on which the writer served it was never completely accomplished until the circulating water pumps were removed from over the crank case where water leaking slightly past the plungers and stuffing-boxes found its way into the crank case and there mixed with the oil.

Troubles from Oil Coolers

Another frequent source of trouble were the oil coolers, where the oil is cooled by circulating water before being again used in the engine system. The oil passed through nests of tubes surrounded by cooling water, and trouble was experienced in preventing tubes from pitting through and gaskets from leaking. Whereas the oil pressure when the engine was running was greater than the water pressure, the leak would become effective when the engine was shut down and the lubricating-oil pumps stopped. Water would

*Abstract from the "Journal of the American Society of Naval Engineers."

then leak in and cause trouble on the next run of the engine. Another source of leaks was from slight cracks in cylinders, sometimes quite imperceptible to the eye when the cylinder was cold, but allowing slight leaks of cooling water to crank case when warm. All these leaks, wherever they may be, must be prevented to insure proper cooling of piston heads and to prevent troubles ensuing from this source.

Wristpin Troubles

Wristpin troubles, in brief, are due to insufficient lubrication, insufficient clearance, undue wear on bushing or pin and heating resulting from hot piston or piston head. The trouble due to insufficient lubrication is sometimes traceable to the salt water in the oil. In other cases, however, it may be due to improper grooving of the wristpin bushing or bearing surface. This subject must be studied in connection with the approved forms of oil grooves for bearings, and steps taken to insure that the oil is being properly distributed on the wristpin bearing.

On engines with forced-lubrication pumps operating from the main engine shaft, hot wristpins frequently develop on first starting up an engine. This is probably caused by lack of lubricating oil in the wristpin bearings, the highest part of the system, when the engine is first turned over. This can be prevented on engines with an independent lubricating pump by starting up the auxiliary lubricating pump several minutes before attempting to turn over the main engines and running it long enough to insure getting lubricating oil to all parts of the system. This should always be done before starting up, as frequently wristpins will run hot and wipe in the few minutes before oil from the attached pumps can get to them.

Insufficient clearance on wristpin bushings sometimes results in not allowing sufficient lubricating oil to form a good film on the bearing and causes wiping or heating of the wristpin. Good practice is to allow about 0.002 in. vertical clearance between the pin and bushing and about 0.006 to 0.008 in. clearance on the sides. This additional side clearance gives no more play in the bearing, as the pressure is always vertical, but gives the oil a better chance to circulate in the bearing and form the oil film or lubrication.

Undue wear on wristpin bushings results in loss of lubricating oil from the bearing due to leakage, and also in loss of compression in the cylinders from the dropping down of the pistons. Consequently, anything that can be done to prevent undue wear on the wristpin bushings is important. In addition, loss of compression in the cylinders causes inefficient combustion of the fuel, reducing the economy of the engine, and necessitates frequent overhaul and insertion of liners under connecting-rods to increase compression, or frequent renewal of wristpin bushings.

The bushings should be of phosphor bronze, of as tough and durable a composition as possible. The wristpins are of steel, hardened on their wearing surface by either the bone or cyanide process. The wristpins furnished us originally were bored out from one end only and that end plugged with a threaded brass plug. We found that the pins would take a more uniform heat and better hardening if the pins before hardening were bored clear through and both ends plugged with the threaded brass plugs. This was a slightly more costly process, but resulted in much better pins, and is recommended for all wristpins for Diesel engines.

Air-Compressor Troubles

Diesel engine air-compressor troubles comprise valve trouble, cooler leaks and explosions. They are due to the high temperatures created when the air is compressed in two or more stages from atmospheric pressure to approximately 1000 lb. per sq.in. In the type of engine mentioned at the beginning of this paper, the compressor was designed to take its suction from the scavenger-air housing, and it was then compressed in two stages in tandem to 800 lb. to 1000 lb. per sq.in. This air was cooled from each stage in a cooler consisting of nests of small, straight tubes around which circulated cooling water. The air from the second-stage cooler passes to the spray-air bottle which acts as a reservoir on the way to the spray-air line of the engine. It will be seen that when the two-stage air compressor takes its suction from the scavenger housing containing air at 7 lb. pressure (above atmosphere) it virtually makes a three-stage compression. On our engine, however, there was always so much oil in the scavenger housing that it was considered dangerous to compress air containing so much oil and subject it to the temperatures reached, and in practice it gave considerable trouble. So the suction to the scavenger housing was disconnected and a suction direct to the atmosphere substituted which gave a straight two-stage compression from atmospheric pressure to 1000 lb. per sq.in. This worked much more satisfactorily as regards presence of oily vapor in the compressed air and occurrence of cooler explosions.

A common practice in Diesel-engine design seems to be to have a restriction in the spray-air line between the reservoir and the engine. The only object of this, that I have been able to discover, is to enable a higher pressure to be carried in the reservoir than is needed on the spray-air system, so as to build up a reserve for starting after the engine has been shut down. If this is its purpose, it never was successful for us, and only resulted in reducing the amount of spray air we were able to get through to the fuel valves. Furthermore, it would frequently clog up and catch dirt and oil to further reduce the opening, so that in general it was more of a nuisance than anything else. Acting on this belief, the restriction on the spray air was removed entirely and much better results in every way were obtained. Whereas, before poor fuel combustion had been obtained when carrying 800 lb. to 900 lb. pressure on the spray air, after removing the restriction perfect combustion was obtained with as low as 550 lb. to 600 lb. pressure on the spray air.

Another point in regard to air-compressor trouble is cylinder lubrication. The principal danger is too much lubrication, allowing oil to be carried into the compressed air and causing high temperatures or explosions from burning or combustion of the oil vapor. The best practice is to eliminate direct cylinder lubrication entirely and depend on the moisture and oily vapor in the engine-room atmosphere to furnish sufficient lubrication. In practice this worked very well for us, and we had no trouble from lubrication while using no oil whatsoever directly on the air compressors.

Valve Troubles

The principal valve trouble which we experienced was due to the valve springs losing their temper after a few hours' running, due to the high temperatures of the uncooled air to which they were subjected. The second-stage suction valve was the principal source of trouble, and when its spring gave out it would leak, allowing second-stage pressure to back up in the first-stage receiver and increase the work on the first stage and in general raise hob. Another source of valve trouble was the gradual collection of carbon deposits on the valve seats due to the presence of oil in the air and causing the valves to leak.

Cutting off the oil used for cylinder lubrication helped both troubles. But the greatest assistance to correct these faults was a water cup installed on the first-stage air suction and set to feed a small quantity of fresh water into the compressor with the air. This water cup was simply a large oil cup arranged for drop feed, filled with fresh water instead of oil. A fairly rapid feed was set on it, about two to four drops per second, and this water was dropped through the top of the air-suction pipe and drawn into the compressor with the air. The action of this fresh water was found to be as follows: It helped to lubricate the valves and cylinder walls and prevented the deposit of carbon. The high temperature almost immediately turned it into steam, absorbing some of the heat without rise of temperature in the form of latent heat, and thus keeping down the temperatures developed due to compression. In addition the steam kept the carbon from collecting and gumming up the valves, and the reduced temperatures resulting prevented the springs from losing their temper. This fresh-water cup was a fine thing, and I strongly advise other Diesel-engine operators to try it on their air compressors.

Cooler leaks were probably caused by high temperatures and possibly some electrolytic action on the tubes. The installation of the water cups kept down the temperatures

and also kept carbon and oil from collecting in the coolers and restricting the heat transference. To prevent electrolytic action the outside of the copper tubes was tinned and small zincs were placed in the cooler. These precautions eliminated almost all of our air-compressor troubles. In addition all clearances were kept down to a minimum, about 1-64 in. on both stages.

Auxiliaries

The principal troubles experienced with auxiliaries were with those geared to the main shaft. These pumps were the reciprocating type and comprised a fuel-feed pump, a lubricating-oil pump and a circulating-water pump, all driven by one large crosshead operated by a crankshaft geared to the mainshaft. The first trouble experienced was with the fuel-oil supply pump, which leaked, in spite of efforts to keep it tight, a small amount of fuel oil into the crank case. After mixing with the lubricating oil this caused rapid deterioration of the latter for lubricating purposes, as well as scavenger and crank-case explosions from its low flash point and volatility. To obviate this trouble the fuel-pump was removed and a gravity fuel feed substituted, the gravity fuel tank being supplied by a small motor-driven rotary pump, secured to the bulkhead. This removed all possibility of getting fuel oil into the lubricating oil and prevented recurrence of its evils.

The lubricating-oil and circulating-water pumps were the next to give trouble. They were high-speed reciprocating pumps, and it was almost impossible to keep salt water from leaking from the circulating-water pump and finding its way to the crank case and, ultimately mixing with the lubricating oil, causing all the troubles already enumerated. In addition, mechanical difficulties with these reciprocating pumps caused by momentary high pressures when the pump became air-bound or through defective valve action, resulted in frequent stripping of gears and breaking of pump crankshafts. These breakdowns finally became so frequent that independent motor-driven rotary-type pumps were installed for both lubricating oil and circulating water. The reciprocating-pump connecting-rod was disconnected and lashed clear, and the salt-water connections were blank-flanged to prevent any possibility of salt water leaks, and these pumps were not used but were kept available for connecting up in case of failure of the independent pumps. In nearly two years of operating they were never needed, the independent pumps operating entirely satisfactorily. As a result of this, we became strong advocates of independent auxiliaries for submarine Diesel engines.

The fuel-measuring pumps were of the plunger type, driven by an eccentric off the mainshaft. The regulation was by means of the suction valves being held open for a part of the discharge stroke to control the quantity of fuel oil discharged to the fuel valves. This regulation was made by the operator through a handwheel controlling the rocker arm operating the valves. These pumps gave very little trouble except from wear, and it was necessary to renew the plungers and barrels about every six months to a year on this account. The plungers were required to fit the barrels very closely on account of loss of pressure through leakage past the plungers. Aside from this amount of wear these pumps gave no trouble, and the method of control was entirely satisfactory.

Inspection of Governors

Ninety per cent. of flywheel accidents are due to a failure of the governor mechanism, therefore the following points should be carefully observed: (a) That the governor mechanism works freely and does not stick in any way; (b) that the governor belt is of ample strength, and does not slip, due to oil or other cause (do not use an old oil-soaked belt); (c) that the governor pulley or gears are tight on their shafts.

Engines have run away due to a key dropping out of the bevel gear on the vertical spindle of the governor, or to the loosening of a setscrew on the governor pulley.

Do not under any circumstances remove or set back the safety-cams on a releasing valve gear or block the governor, so that the governor stop is made inoperative.

Always remove the stop-pin from the governor stand immediately after starting up. This precaution is so often forgotten or neglected that the adoption of a simple semi-automatic device is strongly recommended. It may consist of a small lever pivoted to the governor standard and so balanced that it drops out of place automatically when the momentum of the balls becomes sufficient to lift the governor-rod off it.

A refinement of the same idea, which obviates the necessity of the engineer holding the "pin" in place when shut-

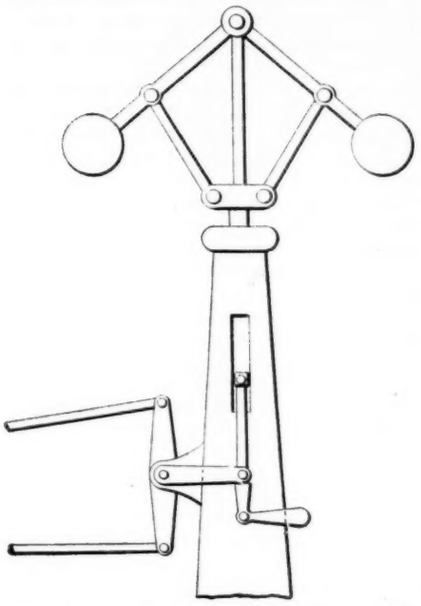


FIG. 1. HANDY AND SAFE STOP PIN

ting down, or else of lifting the governor rod up on the "pin" after the engine has stopped, is shown. This appeared in *Power and the Engineer* for Feb. 2, 1909, from which the following description is quoted:

The device is simple and any engineer can make and attach one himself. The illustration shows three positions. The first is that in which the stop is placed just after closing the throttle and before the speed is much reduced. It will be noted that the fork is not directly under the end of the rod that comes down from the collar. As this rod drops the fork centers and allows the small dog to drop, as shown in the second view. When the engine is again brought up to speed, the rod rises, and the fork is pulled over to one side out of the way by the weighted end as shown in the

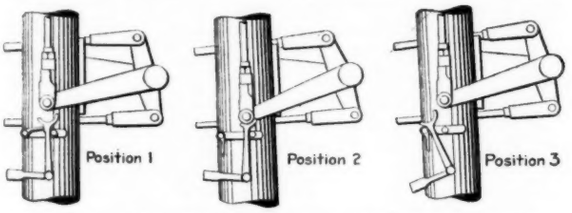


FIG. 2. MODIFIED FORM OF SAFETY STOP PIN

third view. This leaves a clear path for the rod should anything happen to stop the governor.

Never put heavy grease in the oil pot of the governor.

Examine all screws at frequent intervals, especially those in the cutoff and safety cams, to make sure that they do not work loose. The working loose of the lower screw in a cutoff cam some time ago was the cause of a flywheel wreck.

Be sure the stop collar of the governor is in such position that steam is cut off when the balls drop near the low limit. Also be sure that when the governor balls are at the upper limit, the knockoff cams shut off all the steam and do not pass clear under the crab claw and get caught. This was the cause of a flywheel wreck not long ago.—*National Safety Council.*

Plant Records and the Importance of Keeping Them

The following is from a lecture prepared by Prof. L. P. Breckenridge as part of his fuel conservation work for the Fuel Administration:

Unless records are kept, it will be impossible to know whether the boiler plant is operating at a good or a bad economy. Well-kept records are valuable, and reference to them from month to month, or even from year to year, frequently reveals some unsuspected and wasteful method of operation or shows the value of one kind of coal as compared with another. Where records are kept, it gives the fireman a chance to watch the effect of different methods of running; and this of itself will often lead to economy sufficient to repay fully any cost of installing suitable facilities for keeping the records as well as the slight cost of recording the necessary daily observations. When it is known that records are kept, the operating staff begin to take more interest in securing good records.

Records for the Small Plant

It might be well to classify steam-power plants arbitrarily according to their size, and the writer would suggest the following: The small plant, 10 to 100 hp.; the medium plant, 100 to 500 hp.; the large plant, 500 to 5000 hp.; the commercial plant, 5000 to 300,000 hp.

It is in the small plants that is usually found the greatest waste of both coal and steam. Frequently, in these plants as much as ten pounds of coal per hour is used to produce one horsepower. This is much too large an amount. There may be conditions of operation that would sometimes justify this large consumption, but such cases need not be many, and the coal consumed to produce one horsepower should not exceed five pounds per hour even for the small plant. For the small plant the following daily records should be kept in connection with the operation of the boiler: (a) The kind and size of coal used; (b) the steam pressure; (c) the temperature of the feed water; (d) the weight of coal burned; (e) the weight of water evaporated; (f) the weight of ash.

In the medium plant, in addition to the foregoing records, the following should be kept: (g) The temperature of the escaping gases; (h) the temperature of the boiler room; (i) the composition of the escaping gases; (j) the draft pressure in furnace and base of stack; (k) the quality of the steam; (l) the heating value of the coal.

It is, of course, necessary to have the dimensions of boilers and furnaces in order to make the necessary calculations for which these records are kept.

For the large plant and for the commercial plant a few additional records are desirable, but for these plants the records as now usually kept are quite complete, and for many plants the records are continuously recorded.

The coal consumption per horsepower per hour in a medium plant varies greatly, but it is probable that if a large number of plants were taken as they are running today it would be found that at least five pounds of coal was used for one horsepower, when it ought easily to be possible to reduce this to three pounds per horsepower per hour.

In the large plant and in the commercial plant the possibilities for economy increase with the size of the plant; here the coal consumption per hour should never exceed three pounds per horsepower, should usually be well under two pounds, and in some plants operating under best conditions the consumption may soon be as low as 1¼ pounds per horsepower per hour.

How Records Should be Obtained

It is not within the scope of this lecture to explain in detail how the specified records should be obtained. There are available numerous excellent laboratory manuals giving full instructions for the installation and use of instruments necessary or useful in connection with any plan for keeping records. It should, however, be observed that the records suggested for this small plant are very simple and may easily be obtained; for example, the steam pressure is read from the gage on the boiler, a special thermometer is procurable which may be screwed into a fitting in the feed line, or a mercury well with a simple glass thermometer may easily be arranged for the purpose of reading the temperature of the feed water. The weight of coal and ash will require a pair of scales, but a record of wheelbarrow loads properly trimmed off to a known weight is better than no record at all. The weight of water fed to the boiler can best be determined by installing a meter on the feed line. Meters are made for hot or cold water. They are not always accurate, but are easily checked up once or twice a year and for comparative purposes are quite satisfactory. With this simple equipment much valuable information may be obtained. It has been suggested already that consumers of coal must know how it is used, that in the future extreme waste may be prohibited.

How To Use the Records

There are two ways of making good use of the records: (a) Compare your results with the best records obtained with similar equipment elsewhere; (b) compare your daily, weekly or monthly records with one another, with the object of increasing economy or reducing cost of operation. The records should be inspected by someone whose duty it is to look after "waste." If a graphic chart is made from the records, it will often show at once the influence of some unseen leak, the defect of equipment by breakage or improper setting, poor method of operation or change of coal. Corrections may then be made before the "waste" has continued a month or more. Someone in charge of power-plant operation must submit a monthly report to the general manager or owner, and this report must be given some interest and attention. The fireman must be shown his records from month to month and encouraged to fire in accordance with the best-known methods.

Any attempt to reach a conclusion as to what is a satisfactory performance leads to endless discussion. This is natural because of the commercial importance which necessarily must be considered as a part of the problem. When a power plant is manufacturing electrical energy for distribution and sale, the cost of the coal used may constitute 60 per cent. or more of the entire cost of producing its product. If, on the other hand, a power plant is generating 300 hp. for the manufacture of boots and shoes, it may be found that the cost of coal required for power generation and heating is less than 1 per cent. of the cost of production, so that frequently manufacturers have not given much attention to their power-plant operation.

The table is presented with the hope that it may be some indication of what economies may reasonably be expected in the operation of several types of power and heating plant boilers both for the production of steam and the generation of power.

REASONABLE ECONOMIC PERFORMANCE

(Stationary Steam Plants)

Type of Plant	Efficiency of Boiler and Furnace Per Cent.	Coal per Hour, Lb. Per Kw.
1. Central Stations:		
(a) Large, 10,000 kw. and up	70–76	3–2
(b) Small, 2,000–10,000 kw	68–74	4–2½
2. Manufacturing power plants:		Per I.Hp.
(a) Small plants up to 100 hp	60–70	8–5
(b) Medium plants 100–500 hp	68–72	5–3
(c) Large plants 500–2,000 hp	68–74	4–2½
3. Heating plants:		Per Boiler Hp.
(a) Central 1,000 hp. and up	68–74	4–3
(b) Office buildings, public bldgs.	50–70	6–3
(c) Residences	50–65	....

Even better results than those indicated are now frequently found, but it is a fair question if plants should be allowed to operate under conditions which give efficiencies below the low points indicated.

In order to standardize the form of report submitted by engineers and also to suggest approved methods of testing the different kinds of equipment, the American Society of Mechanical Engineers appointed in 1909 a Power Test Committee. This committee has prepared the "Power Test Code" of the A. S. M. E. This code was printed in 1915 and is available. It is being revised and extended and will soon be in excellent form for general use for all engineers and manufacturers. It is hoped that all important tests

will conform to this code. In it will be found not only forms and methods, but also much detailed information as to the installation and use of the various instruments of precision employed in connection with tests of all kinds. All students of engineering should become familiar with this "Code of Rules for Conducting Performance Tests of Power Plant Apparatus."

The Fuel Administration's Regulations as to Clean Coal

The order of the United States Fuel Administration regarding the production of clean coal went into effect Mar. 11, 1918. According to its terms, district representatives of the Fuel Administration are authorized to appoint inspectors in sufficient numbers to carry out the provisions of the order.

The duty of each inspector is to make frequent and thorough inspections of the coal mined in the particular territory to which he is assigned and to observe the conditions under which it is mined and produced. If he finds the coal in any part of a mine to be naturally of such character as to be unfit for market, the district representative may order mining suspended in that part of the mine until proper cleaning methods are adopted; but work cannot be so suspended if it endangers life or if it may result in flooding or squeezing.

The inspector must make a daily report to the district representative of the Fuel Administration, stating the number of mines inspected, the condition of the coal as loaded, the methods used to prepare and clean the coal, and whether, in his judgment, the product being shipped to market is a well-prepared and merchantable product.

If an inspector finds coal loaded in railroad cars at the mines and is not of the opinion that it is properly prepared, he may condemn it. But he must immediately notify the district representative and the operator by wire or in person and in writing, giving the car numbers and initials of any and all cars so rejected and stating the reasons for his action.

If the district representative approves the inspector's report, he must notify the operator at once. If the operator does not unload the rejected coal at once and reprepare it, the consignee is permitted to deduct 50 cents per ton from the authorized price for the grade of coal in the car; but the consignee, after examining the coal, may at his option pay, and the operator may receive, the full authorized price.

Each invoice covering the sale of condemned coal must bear a notation to the effect that the reduced price is fixed by the United States Fuel Administration as a penalty for improper preparation. The operator must immediately report to the United States Fuel Administration at Washington and to the district representative how he disposed of the condemned car or cars of coal and a copy of the invoice must accompany his report.

The terms, conditions and validity of existing contracts are not affected or altered by the clean-coal regulations; but all new contracts are subject to the provisions of the order.

The object of the order, of course, is to discourage the marketing of slate, bone and other impurities at the same price as clean coal. But the regulations apparently contain a "joker." For, after stating that the consignee may purchase the condemned coal at a reduction of 50 cents a ton, they add:

. . . provided, however, the consignee, after examining the coal, may, at his option, pay and the operator receive the full authorized price.

Commenting on this provision, a writer in *Fecony* pertinently remarks:

Why were such pains taken to permit a producer of poor coal, a waster of our National resources, to receive "the full authorized price?" The coal market is a "sellers' market," and it will be for some time to come. Every coal producer knows that most manufacturers have very small reserves, and that once a car of coal is on a consumer's side-track, it is ten to one that he will not reject the coal, especially as he has probably been counting on the arrival of that car. How easy it will be to insist on "the full authorized price." Even if the original consignee is in a position to reject a particular car, every coal producer knows it is a safe bet that there is at least one near-by plant that will be glad to take anything to tide over a temporary shortage at any price. What chance is there of an operator actually suffering any penalty for poor preparation, and besides how many of the seven or eight million carloads shipped to manufacturers and retail dealers are going to be "inspected"?

Careful provision is made in the order for notifying almost everybody by telegram of the condemnation of a car, except the consignee. If the Fuel Administration is really interested in the maximum manufacturing efficiency, why wasn't provision made for prompt notice to the consumer that a car of condemned coal is on the way? Is the operator going to do it voluntarily? Is he going to rush off by special-delivery mail the invoice, showing that the car contains condemned coal, so that the consumer can make other arrangements for coal to take its place?

Carbocoal

A paper prepared by Charles T. Malcolmson, president of the Malcolmson Briquette Engineering Co., Chicago, for presentation at the Colorado meeting of the American Institute of Mechanical Engineers in September of this year, describes a process for the manufacture of smokeless fuel from high-volatile coals and for the recovery and refinement of the coal-tar products derived therefrom. The products of the process are a fuel called carbocoal, which, for convenience in handling, is prepared in briquet form; a yield of tar more than double that obtained in the ordinary byproduct coking process; ammonium sulphate in excess of that normally recovered in the ordinary byproduct coking process; and gas in amount approximately 9000 cu.ft. per ton of coal carbonized, which is at present used in the process.

The raw coal, after being crushed, is first distilled at a temperature of 850 to 900 deg. F., and the volatile contents are thereby reduced to the desired point. The result of this first distillation is a large yield of gas and tar and a product rich in carbon, termed semi-carbocoal. This product is mixed with a certain proportion of pitch obtained from the tar produced in the process, and the mixture briquetted. The briquets are then subjected to an additional distillation at a temperature of approximately 1800 deg. F., resulting in the production of carbocoal, the recovery of additional tar and gas, and a substantial yield of ammonium sulphate.

The carbocoal represents more than 72 per cent. of the weight of the raw coal, the exact percentage depending upon the volatile content of the latter. It is dense, dustless, uniform in size and quality, and can be handled and transported long distances without disintegration. It is grayish black in color, slightly resembling coke, but in density more nearly approaches anthracite. It is applicable to about the same kind of service as anthracite would be, one of its most valuable characteristics being that of smokelessness.

Uruguay Requires Use of Metric Units

One of the measures recently adopted by the Government of Uruguay, says *Commerce Reports*, makes the use of metric units in all trade transactions obligatory. A decree of Feb. 8 provides that merchants dealing in articles susceptible of being sold by weight or measure must adhere to the metric system and forbids them to sell by the piece or package or for a fixed sum of money, even when the customer so demands. Where merchandise is sold in sealed wrapping, cans, boxes, packages, bottles, demijohns, etc., the net contents or weight contained must be indicated on the wrapping in an easily visible manner. In books of account and invoices the weight or measure of merchandise sold must be stated. Merchants dealing in articles of prime necessity must post in their places of business the daily prices of such articles, stating the weight or measure.

It is very advisable to have more than one way of getting out of a boiler or engine room, even if one of them is not very handy.—*Marine Engineering.*

Power for the Nitro Powder Plant

The United States Government has not only entered into a contract with the Virginian Power Co. of Charleston, W. Va., to furnish power from its plant at Cabin Creek Junction, near that city, for the mammoth powder plant at Nitro, about 16 miles below Charleston, but has arranged for an interchange of current between the Virginian Co. and the Appalachian power concerns, the two largest power companies in the state.

To insure adequate current for the Government needs at Nitro, the producing capacity of the Virginian's plant is being trebled, and an expenditure said to be in the neighborhood of $1,000,000 will be necessary to cover all the improvements. Some time ago, the company actually began to install new machinery sufficient to double the capacity of the plant, but owing to the condition of the money market was unable to finance the completion of such improvements. Not long ago officers of the company presented to the Government the proposition of assisting in the enlargement of facilities without waiting for an easier money market. It is believed that the negotiations led to the contract that has been made between the Government and the Virginian company.

General Manager H. G. Scott has made this statement in connection with the new arrangement:

It was announced to the Public Service Commission that the Virginian Power Co. has concluded a contract with the United States Government whereunder all the electric-power requirements of the power plant at Nitro will be taken care of by the Virginian Power Co. from its plant at Cabin Creek Junction.

The contract provides that two circuits over two separate and distinct routes shall be constructed for the service of the powder plant only. The contract was so arranged by the Government as to provide for the full power requirements of the coal mines. The equipment now being installed at the company's plant is practically the same which the company has had ordered for about a year. This contract, however, provides not only for the completion of the installation, but that it shall be done immediately.

It is planned to physically connect the power systems of both the Virginian Power Co. and the Appalachian Power Co. in order that these companies may interchange power for the purpose of sustaining the service in the most continuous and economical manner. This plan has been successfully carried out in California, where all the larger companies are interconnected.

Injury by Defectively Repaired Boiler

"A steam boiler is inherently dangerous, and one who repairs it owes a duty of proper care to avoid injury, not only to the property and employees of the purchaser, but to all persons who may be thereby subjected to injury, and to that end must perform his work properly." This language was lately used by the Appellate Division of the New York Supreme Court in the recent case of Rosenfeld vs. Albert Smith & Son, Inc., et al.; 168 New York Supplement, 214. The court affirms judgment for death of a youth who was standing near a boiler in the power plant of a hotel building when the rear boiler head bulged out and steam escaped in fatal volume.

A hotel company holding a lease on part of the building contracted with the appellant, Albert Smith & Son, for the replacing by the latter of tubes in two boilers, the work to be done in a first-class manner and to be "perfectly tight." In the process of doing the work, appellant's employees used shims 1/32 in. thick to fill the spaces between the ends of the tubes and the inner surface of the boiler heads. But the shims were not continued all the way around each tube, being tapered or scarfed at the ends and extending only about halfway around the tubes. Apparently it was not claimed that there was any negligence in failing to bead the tubes, instead of using shims, but plaintiff offered evidence tending to show that the shims should have been extended all the way around, and that they should have projected beyond the boiler heads instead of being flush as they were, and should have been flared with the tube ends so that they would tend to resist the pressure from within and prevent the bulging out of the boiler heads. It was found after the accident that the rear boiler head had bulged out on a vertical line three-fourths of an inch, resulting in 27 tubes in the center dropping inside the boiler and the other tubes being left barely holding.

The assistant engineer testified that the gage registered only 97 lb. a few minutes before the accident, although after the tubes had been installed the boiler had been subjected to hydrostatic tests of 160 and 190 pounds.

Appellant contended in the suit that, even if it were conceded that the boiler was negligently repaired by its workmen, still the engineer in charge of the plant had tested and accepted the boiler as being in satisfactory condition. But the court decided that, under the facts established, it did not appear that the engineer was authorized to waive any defects in the boiler, and that the only bearing the tests had was as evidence on the question whether the boiler was skillfully repaired or not.

The court further held that the jury's finding that the work was negligently performed was partly sustained by testimony showing that on the first test 29 tubes were found to be leaking and sweating, and other testimony tending to show that the final test, made after further repair, was not properly or sufficiently made. Concluding, the court said:

The appellant is chargeable with notice of the fact that the tubes were not merely intended as conduits for heat, but that they were intended to support and sustain the boiler heads, and it failed to install them in such manner that they would afford proper support in that regard. The appellant was chargeable with knowledge of the dangers to those lawfully on the premises in the event that the boiler head gave way, owing to its negligence in making the repairs. A steam boiler is inherently dangerous, and one who repairs it owes a duty of proper care to avoid injury, not only to the property and employees of the purchaser, but to all persons who may be thereby subjected to injury, and to that end must perform his work properly.

Perhaps You Can Render Valuable Service to Your Country

Important chemical and other technical engineering work necessary for the prosecution of this war is being carried on by the Bureau of Mines Experiment Station, at Washington, D. C. The services of trained men of the following classifications are urgently needed: Bacteriologists, biologists, chemists (inorganic, organic, physical and electro-), chemical engineers, draftsmen, electrical engineers, instrument makers, laboratory assistants, laborers, machinists, physiologists, plumbers, steamfitters, stenographers, skilled labor of various kinds.

If your training fits you for any of these occupations, send to the Bureau of Mines, American University Experiment Station, Washington, D. C., for blank forms. When properly executed and returned, these forms will be placed on file, and when a vacancy occurs you will be considered for it and will be notified if your services are desired.

If you are a registrant in the draft and have not yet been ordered to camp, it may be possible to have you immediately inducted into the service for work here.

If you are not in the draft, but feel that you wish to serve your country in the present crisis, you can enlist or serve as a civilian. Serve your country where you can serve it best.

A Washington contemporary says it leaked out in the Department of the Interior that the commission of eminent scientists appointed by Secretary Lane to judge whether the inventor, Garabed Giragossian, is right or wrong, the names of whom have been kept a secret, will be headed by James Ambrose Moyer, of Norristown, Penn. Professor Moyer is Director of the State Department of University Extension in Massachusetts and has been in charge of the Department of Mechanical Engineering at the Pennsylvania State College; also an engineer with Westinghouse Church Kerr & Co. and engineer of the Steam Turbine Department of the General Electric Co. He is the author of works upon Steam Turbines, Thermodynamics and Power-Plant Testing.

Tube Thickness Considered at Massachusetts Hearing

A recommendation that the minimum thickness of tubes in water-tube boilers be standardized in accordance with the A. S. M. E. Code and inserted as an additional section in the Massachusetts Code of Boiler Rules was presented at Boston, May 2, to the Board of Boiler Rules by the Mutual Boiler Insurance Co., Boston. This matter and a petition that the rules be altered to permit the use of the Breakey type of automatic gage-glass cutoff were the only subjects brought before the board at the semiannual hearing, at which George A. Luck, deputy chief of the Boiler Inspection Department of the Massachusetts District Police, presided.

The first petition urged the addition of Sec. 7 to Part 3 of the 1917 Rules, to read as follows:

TUBES FOR WATER-TUBE BOILERS

The minimum thicknesses of tubes, circulating pipes and nipples used in water-tube boilers, measured by Birmingham wire gage for maximum allowable working pressures not exceeding 165 lb. per sq.in. shall be as follows:

Diameters under 3 in	No. 12 B.w.g.
Diameters of 3 in. or over, but under 4 in	No. 11 B.w.g.
Diameters of 4 in. or over, but under 5 in	No. 10 B.w.g.
Diameter of 5 in	No. 9 B.w.g.

The above thicknesses shall be increased for maximum allowable working pressures above 165 lb. as follows:

Above 165 lb., but not over 235 lb	1 gage
Above 235 lb., but not over 285 lb	2 gages
Above 285 lb., but not over 400 lb	3 gages

Tubes over 4 in. in diameter shall not be used for maximum allowable working pressures above 285 pounds per square inch.

John A. Collins, secretary of the Mutual company, urged the above incorporation on the ground of increased safety. He said that water-tube boilers are now being built in Massachusetts for 200 lb. pressure, using No. 10 B.w.g. tubes. For the past fifteen years the Mutual company has been recommending even heavier tubes than are called for in its petition. Nothing was included in the section relative to tube quality, but in answer to an inquiry, Mr. Collins stated that seamless-drawn tubes are greatly to be preferred to lap-welded. This was not incorporated in the recommendation because of the great difficulty today in obtaining seamless-drawn tubes.

J. F. Molloy, chief inspector of the Mutual company, said that he knew of a public-utility company in Massachusetts which is installing ordinary standard-gage No. 10 tubes in water-tube boilers for 200 lb. pressure; and it is not known what the actual thickness of the tubes is. These tubes may run as small as No. 11 or No. 12 for all that the inspecting company can tell. Another plant, soon to be operating at 300 lb. pressure, is putting in No. 7 gage. Under the present Massachusetts rules the use of No. 25 gage would be possible in this case. Mr. Molloy said that most accidents his company had noted in water-tube boilers came from the rupture of the tubes. No trouble has been experienced from the collapsing of fire tubes. The company has issued specifications for No. 11 gage tubes in boilers operating at 175 lb., in some of its practice. It is an open boast today among boilermakers that they would rather bid on the Massachusetts Code than on the A. S. M. E. There was no opposition to the proposed new section.

L. I. Breakey, Marshall, Mich., petitioned the board for a change in Rule No. 27, Part 3, Sec. 6, page 98, Rules of 1917, which prohibits the use of an automatic shutoff valve on a water-glass connection. The petition stated that a large number of states have changed this rule so as to admit the use of automatic shutoffs, of which there are now several makes. The Breakey shutoff is indorsed by the Ohio State Board of Boiler Rules and the Pennsylvania Industrial Board as applied to steam boilers, and it meets the A. S. M. E. Code as governing water gages. The proposed change in the rule reads as follows:

No water-glass connection shall be fitted with an automatic shutoff valve except where the automatic shutoff valves are so constructed that the two connections to the water glass can be blown through and the steam connection cannot be entirely closed thereby; means must also be provided for the renewal and inspection of the upper and lower ball check valves while the boiler is under working pressure.

There was practically no discussion of this recommendation with the exception of a comment by James Stewart, Stewart Boiler Works, Worcester, Mass., who queried the continuous reliability of any spring-actuated device and who emphasized the great importance of making such equipment foolproof. The hearing was then closed.

Government Will Open Up Fuel Oil Reserve

The naval fuel-oil reserve in California will be opened up by the Government immediately to prevent an oil famine. Assurance to this effect was given to a delegation of prominent newspaper publishers from the Pacific Coast after conferences with Secretary of the Navy Daniels, Bernard M. Baruch, chairman of the War Industries Board; Mark L. Requa, director of the oil division of the United States Fuel Administration, and representatives of eighty litigants who have numerous claims against the property now included in naval reserve No. 2.

Requa, the oil director, after the conference served notice upon the litigants that if they do not adjust their differences with the Government within two weeks so amicable settlement of disputes can be made after the war, the fields will be commandeered as a war measure.

Secretary Daniels, who took the precaution four years ago to conserve the great oil fields, gave his hearty consent to the opening up of the naval fuel-oil reserves.

Baruch said he not only could see the great and pressing need for it, but would suggest to President Wilson the commandeering of the entire Pacific Coast oil industry, if such steps were necessary.

The publishers, who were headed by F. W. Kellogg, of the San Francisco *Call*, first went to see Baruch. They explained the serious fuel-oil situation that faced not only the coast but the whole country.

They said fuel commissioners had told them there were in storage on Jan. 1, 19,000,000 bbl. of fuel oil. There will be produced under the present maximum conditions 78,000,000 bbl. of oil this year. The consumption at the present rate will require 96,000,000 bbl. This would leave only 1,000,000 bbl. at the end of the year. The reserves are decreasing at the rate of 1,500,000 bbl. a month.

Of the 2,400,000 hp. produced on the coast, nearly 75 per cent., or 1,500,000, is developed by fuel oil, 380,000 by water, 100,000 by coal and 100,000 by gas.

Fifty-seven per cent. of all the fuel oil is now used by railroads and vessels, including naval ships. The shipping board's program contemplates the use of fuel oil in about 35 per cent. of the merchant fleet. Unless this is met by additional and immediate increase in production industries depending on fuel oil will be paralyzed.

According to *Commerce Reports*, a new syndicate has been formed by Einar Steensrud, of Skien, Norway, for the consolidation and developing of a number of small waterfalls, aggregating 200,000 hp. The present intention is to utilize this power for the manufacture of nitrate, aluminum or carbide, according as the demand develops. The annual report of the Norsk Hydro has appeared, covering the year ended June 30, 1917. The net profit was $6,650,000, compared with $4,900,000 in the previous year. The capital stock is $15,450,000. This company operates waterfalls of about 300,000 hp. for the production of electrochemical commodities like nitrates and carbide. In the production of all of these commodities great heat is generated, and heretofore much of it has been wasted. By a new arrangement the waste heat is now to be utilized for the production of low-pressure steam to operate turbines.

The noncompressibility of water, coupled with the thickness of some men's heads, has helped the repair shops to several millions of dollars of work. We cannot change the nature of water, but we can do something with the men's heads.—*Marine Engineering.*

Detroit Engineering Societies' Joint Meeting

The Detroit Engineering Society and the Detroit Section of the American Society of Mechanical Engineers held a joint meeting Friday evening, May 3, in the Board of Commerce Auditorium. Dean Cooley, of Michigan University, announced a course in elementary drawing and training for women at the summer school this year, to meet the demands of the drafting room. These women will be taught to do the more elementary work, thus relieving the regular draftsmen and designers. The movement was promised the hearty coöperation of both societies, which passed a resolution to place the graduates and give the matter the necessary publicity to interest other schools in this line of endeavor.

The paper of the evening was by R. H. Kuss, consulting engineer, of Chicago, on "Coal Conservation as Applied to Boiler-Room Operation." Mr. Kuss pointed out that coal is the greatest factor in this war, one-third of the cost of living reverting to this product. A table of the use of coal was shown.

ESTIMATED EFFICIENCY WHEN BURNING BITUMINOUS COAL

	Stationary Plants			
	High	Low	Locomotive	Domestic
Poor practice, per cent	50	40	60	30
Fair, per cent	64	56	66	40
Good, per cent,	72-74	62	70	50
Available, per cent	76	68	72	55
Available decrease, per cent	12	14	9	15
Available saving, tons	25,800,000		17,100,000	20,250,000

Total available saving, 63,150,000 tons on 1917 basis.

These figures are based on observations and statistics for 1917. The available percentage is not a theoretical saving, but is based on actual practice in carefully watched plants. The available decrease is the percentage that could have been saved by careful methods, with improvements in present equipment. Considering that the output of bituminous coal for 1917 was 540,000,000 tons and the estimated requirement for 1918 is 619,000,000 tons, the necessity of preventing this waste may readily be seen.

Mr. Kuss put the problem to the engineers as their own. He showed that under new district regulations coal would be burned in fireboxes not fitted for its proper combustion and that it is the engineers' duty to see that janitors and owners of homes are taught to fire properly.

He pointed out the steps to be followed in good practice, such as tight fireboxes; the necessary combustion-chamber construction so that the air and distilled gases may have time to mix and combine before coming in contact with the relatively cold surfaces; frequent cleaning of both sides of heating surfaces. Great stress was laid on the draft control and the proper supply of air, it being as wasteful to use too much air as to use too little. Mr. Kuss spoke of the difficulties the efficiency engineers would encounter and suggested ways of overcoming them, such as: Keep in touch with the chief operator, he knows the conditions better than anyone else; study the plant over a long period; talk to the men so that the suggestions for improvement may come from them, and in some cases use opposition so that the operator will work hard to prove his point.

The engineers were warned that in the near future the Government would compile a classification list of the boiler plants in an attempt to show the grade of equipment, and that coal will be distributed on virtue of existing boiler plants.

The societies passed a resolution to maintain a joint committee to aid the Fuel Administration along the lines of good practice.

Responsibility for Injury in Horse-Play

If a fireman employed in a boiler room left his employer's premises to chase a man who had called him "Turkey," and was injured while so engaged, there can be no award under the New York Compensation Act on a theory that the accident occurred in the course of the fireman's employment. (New York State Industrial Commission's December, 1917, Bulletin, p. 82. Sullivan vs. Beach Gasper Company.)

Thermal Values of Soft Coals

From Selected Free-Burning and Caking Soft Fuels. From U. S. Geological Survey Bulletin No. 332 and U. S. Bureau of Mines Bulletin No. 23.

State	Test No.	Kind of Fuel	County	B.t.u. per Lb.
Alabama	375	Soft—caking	Bibb	13,671
Alabama	484	Soft—free-burning	Jefferson	14,447
Arkansas	293	Soft—caking	Sebastian	13,705
Arkansas	308	Semi-anthracite—caking	Johnson	14,125
Arkansas	340	Lignite	Ouachita	9,549
Georgia	481	Soft—free-burning	Chattooga	12,865
Illinois	448	Soft—free-burning	Williamson	12,920
Illinois	511	Soft briquets	St. Clair	13,271
Illinois	509	Soft—caking	Saline	13,621
Indiana	428	Soft—free-burning	Greene	13,099
Indiana	435	Soft—caking	Pike	13,545
Indiana	464	Soft briquets	Parke	11,930
Indian Territory	437	Soft—free-burning		13,932
Indian Territory	449	Semi-anthracite		14,682
Kansas	311	Soft—free-burning	Linn	12,343
Kentucky	434	Soft—free-burning	Union	14,026
Maryland	490	Soft—free-burning	Allegany	14,515
Maryland	518	Soft briquets	Allegany	14,717
Missouri	319	Soft—caking	Randolph	11,747
Montana	477	Lignite—free-burning	Carbon	11,628
New Mexico	392	Soft—caking	Colfax	13,059
New Mexico	387	Soft—free-burning	Colfax	12,721
Ohio	483	Soft—free-burning	Belmont	13,381
Pennsylvania	473	Soft—caking	Indiana	14,240
Pennsylvania	499	Soft—free-burning	Cambria	14,119
Pennsylvania	514	Soft briquets	Westmoreland	14,382
Tennessee	409	Soft briquets	Claiborne	14,092
Tennessee	368	Soft—free-burning	Campbell	14,008
Tennessee	363	Soft—caking	Grundy	13,257
Texas	291	Lignite—free-burning	Wood	11,131
Utah	404	Soft—free-burning	Summit	12,586
Virginia	482	Anthracite—free-burning	Montgomery	12,679
Virginia	507	Soft—caking	Tazewell	14,177
Washington	290	Sub-bit.—free-burning	King	11,772
Washington	359	Soft—free-burning	Kittitas	12,996
West Virginia	305	Soft—free-burning	Marion	13,964
West Virginia	439	Soft—caking	Kanawha	13,995
Wyoming	399	Soft—free-burning	Carbon	12,222
Wyoming	400	Sub-bit.—free-burning	Uinta	12,488

These values give in B.t.u. the theoretical thermal value of soft coals as obtained at the St. Louis Testing Plant from 139 samples of coal, and were established by "actually burning one grain of the air-dried coal in oxygen in a Mahler-bomb calorimeter."

Melting Points of Different Metals

	Deg. F.		Deg. F.
Aluminum	1,400	Iron (east)	2,450
Antimony	810	Iron (wrought)	2,912
Bismuth	476	Lead	608
Brass	1,900	Platinum	3,080
Bronze	1,692	Silver (pure)	1,873
Copper	1,996	Steel	2,500
Glass	2,377	Tin	446
Gold (pure)	2,590	Zinc	680

Bulletin Board Series No. 650

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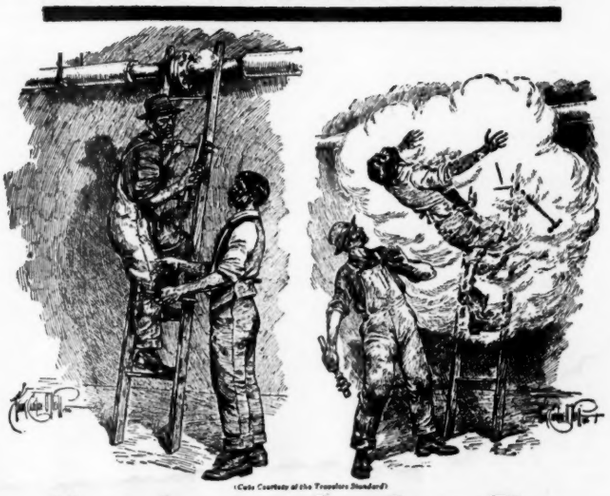

(Cuts Courtesy of the Travelers Standard)

Never do any work on Steam Pipes While They Are Under Pressure

Additional copies of this Bulletin can be secured at cost price from the National Safety Council, 168 South La Salle Street, Chicago, Ill. 5-18

Compensation Act Applied

A novel question was presented to the Connecticut Supreme Court of Errors in the late case of Richards vs. Indianapolis Abattoir Co., 102 Atlantic Reporter, 604. Plaintiff, an employee engaged in work disconnected from the company's power plant, found it necessary to wait for about fifteen minutes before he could use an elevator in proceeding with his work, and sat down on a near-by keg in the power plant, close to a firebox and boiler. Being tired, he dozed off to sleep and awakened a few minutes later to find that his clothing had caught fire, either from radiated heat of the firebox or from a flying spark. His demand for compensation to cover resulting injury was resisted on the ground that he was not injured in the course of his employment, but the court permitted recovery, saying: "The falling asleep of the claimant was natural in the case of a man who has been engaged in hard work for the whole morning in the cold, and who at the time was sitting in a hot place. The falling asleep was not the result of any conscious effort on the part of the claimant, but came simply from drowsiness which crept over him as the result of his previous exertion. The accident occurred when the claimant was at a place where he might reasonably be. There was no turning aside on his part, no attempt to serve ends of his own."

New Publications

ELEMENTARY MECHANICS FOR ENGINEERS. By Clifford Newton Mills. Published by D. Van Nostrand Company, New York City. Cloth, 5 x 7¼ in.; 127 pages. Price $1.

This is another of a number of similar books which have appeared in the last three or four years and is arranged for students who have previously studied trigonometry. It is intended as a basis for a semester's work of three hours per week. The subject matter is divided into three parts—kinematics, kinetics and statics. Throughout many problems have been given, so that the students may master the subject by working on the many problems given. The problems are well presented and for the man who has been through trigonometry, the book is well worth a dollar.

HANDBOOK OF ENGINEERING MATHEMATICS. By Walter E. Wynne and William Spraragen. Published by D. Van Nostrand Co., New York City. Flexible leather, 4¼x7 in.; 220 pages. Price, $2.

Many engineers and students will greatly appreciate this little book, which, as the introduction by Prof. Ernest J. Berg, consulting engineer, General Electric Co., Schenectady, N. Y., states is intended primarily for students in engineering schools and colleges and should serve as a convenient reminder of things that are easily forgotten, but are likely to be needed in their later work. This is certainly the most useful purpose of the book.

The authors have endeavored to supply a ready means of reference to theoretical and applied mathematics as used in engineering, and it includes the underlying engineering data and applications as well as the mathematical formulas. The first 89 pages are devoted to pure mathematics including everything from algebra to calculus and theoretical mechanics, the latter embracing gravity, inertia, impact forces, friction, etc. The remaining chapters treat of the mechanics of materials, hydraulics, flow of liquids, electricity, to measurement and physical and chemical constants. Pages 185-213 are devoted to tables of circumferences and areas of circles; powers, reciprocals; common logarithms; natural logarithms; trigonometric functions; hyperbolic sines and cosines.

It is a mighty good little book to have around to refresh the memory, and we shall be glad to keep it on the shelf near our desk.

STEAM TURBINES. By William J. Goudie. Published by Longmans, Green & Co., New York City. Size, 6 x 9 in.; 519 pages; illustrated. Price $4.

This is one of two unusually good books on steam turbines to appear in recent months. [The other is "Steam Turbines," by G. J. Meyers, Lieut. Comm. U. S. Navy, and published by the United States Naval Institute; it will be reviewed in an early issue of "Power".] It has been the aim of Mr. Goudie to present a volume to suit the requirements of engineering students, chiefly, though there is indeed much to interest the designer and operator; in fact, the book is one that should be of considerable help to anyone interested in steam turbines. Condensers and condensing apparatus are not discussed.

The chapter on classification of turbines has some diagrams showing the behavior of velocity and pressure in turbines of the various types, which we are glad to see in a book of this kind. Such diagrams are of considerable aid to the student particularly. Throughout the book there are many excellent line drawings of sections of turbines of various types; in these drawings details are well illustrated.

The book is particularly pleasing because one finds something of what one looks for—and one looks for many data, drawings, tables, etc., on turbines these days. This thoroughness, which is true of all the sixteen chapters, makes the volume the kind one wants within reach. We have had our review volume a long time, using it for reference and checking—the best way to review a book, of course. The chapter headings are: Classification of Turbines; Impulse Turbines; Reaction Turbines; Combination Turbines; Properties of Steam; Entropy Diagrams; Nozzles; Blading; Rotors; Mechanical Losses; Reheat Factors; Steam Consumption; Determination of General Proportions of Turbines. There are three chapters dealing with this last subject, and in them the author has given many excellent formulas. The last chapter deals with governing.

ELEMENTS OF FUEL OIL AND STEAM ENGINEERING. By Robert Sibley and Charles H. Delany. First Edition. Published by the Technical Publishing Co., San Francisco, Calif. Cloth, 6 x 9 in.; 320 pages; illustrated. Price, $3.

The authors have had considerable experience in fuel-oil burning, on the Pacific Coast particularly. In their preface they state that it has been their underlying aim to study fuel-oil power-plant operation and the use of evaporative tests in increasing the efficiency of oil-fired plants. To accomplish this end, the subject matter has been treated in three main divisions: First, an exposition of the elementary laws of steam engineering; second, the processes involved in the utilization of fuel oil in the modern power plant; third, the testing of boilers when oil-fired. In treating the first subdivision, the elementary laws of steam engineering are set forth in a new manner in that the viewpoint is taken from that of the oil-fired instead of the coal-fired plant operator. In the second division the results of considerable labor and analyses are set forth from the collecting and collating of data involved in boiler-furnace and fuel-oil tests, many of which have appeared heretofore in disconnected form and in widely varying sources. In the first subdivision the authors have given definite suggestions for fuel-oil tests—largely suggestions recently presented personally by them at the invitation of the power test committee of A. S. M. E. The matter which deals altogether with fuel oil does not begin until Chapter 12 is reached; but from here on the authors have placed much that is of value on the subject, which for the East particularly, grows in importance. One can justly criticize some of the illustrations used in the book because of their smudgy appearance, which is not due to printing. The text matter is so well arranged that it seems unfortunate that so many of the illustrations should have been reproduced from cuts that were evidently made direct from other printed matter. There are, however, some excellent halftones throughout the book, among which are the views of the economy measuring apparatus installed at the Long Beach plant of the Southern California Edison Co.

Altogether the book is a desirable addition to the few volumes now available on this subject.

ELECTRIC WELDING MANUAL

The Wilson Welder and Metals Co., New York City, has issued a 45-page booklet devoted in part to instructions for installing and using its system of electric welding. Wiring diagrams and tables, dimensions of motor generators, brackets, etc., are given. Tables showing the melting points of various metals and alloys, and instructions for the care of metals appear in the booklet. Pages 37-39 show typical examples of prepared and finished work.

PURCHASING COAL BY SPECIFICATION AND METHODS OF SAMPLING

The Pennsylvania State College, Engineering Experiment Station, has completed a reprint from the annual report of 1913-14 in which are set forth methods of purchasing coal by specification and of sampling coals for analyses. The subject is treated of by J. A. Moyer and J. B. Calderwood. The pamphlet contains 158 pages and gives the methods of gathering coal samples as used by the Bureau of Mines, Interboro Rapid Transit Co., New York City, United States Steel Corporation, General Electric Co., and Detroit United Railways. Methods of coal sampling and analyses of the American Chemical Society and of the American Society of Mechanical Engineers, also are given. Discussion of the determination of volatile matter in coal is given on page 149 of the bulletin and is of interest. We understood that the bulletin is for distribution free.

U. S. STEEL CORPORATION'S METHODS FOR SAMPLING AND ANALYZING GASES

The second edition of this valuable pamphlet (6 x 9 in., 60 pages) by the Chemists' Committee of the corporation, has been completed. In the methods set forth in the bulletin there has been an unwavering purpose to eliminate, as far as possible, tedious analytical procedure and the use of cumbersome forms of apparatus. It has been desired to adopt methods correct in principle which, in conjunction with the simplified apparatus, will insure the requisite expediency at times so necessary in commercial work without an appreciable sacrifice in accuracy of results. The pamphlet deals, of course, with all the gases met with by the various companies in the corporation. Among these are blast-furnace gas, the analysis of which becomes of increasing importance because of the extensive use of this gas in waste heat boilers; producer gas; byproduct gas; flue gas; and natural gas.

On page 48 an interesting table is given: The products of combustion from burning pure carbon would contain 20.9 per cent. carbon dioxide, since it has the same volume as the oxygen used. The byproducts of combustion of coal contain less CO_2 than 20.9 due to the fact that the hydrogen of the coal requires oxygen from the air, resulting in more nitrogen than if pure carbon were burned. The percentages of carbon dioxide in the products of combustion resulting from perfect combustion of various coals have been calculated and are given here for comparison.

	Per Cent.
Anthracite culm, Scranton, Penn.	19.5
Semi-anthracite, Coalhill, Ark.	19.0
Semi-bituminous, W. Va.	18.8
Bituminous coking, Connellsville, Penn.	18.8
Bituminous noncoking, Hocking Valley, Ohio	18.7
Sub-bituminous, Unita County, Wyo.	18.9
Lignite, Milan County, Tex.	19.2

The latter pages of the booklet have three valuable tables giving the chemical symbol, specific gravity, weight, heat of combustion, volume of oxygen necessary for combustion, and the products of combustion. The second table, on aqueous vapor, gives the pressure in inches of mercury for different degrees F., and the weight in grains per cubic foot. The third table gives factors for reduction of the volume of gas at standard conditions of 62 deg. 30 in. mercury.

The booklet is the best to come to our attention on the subject of gas sampling and analyzing.

J. N. Camp is chairman of the Chemists' Committee, United States Steel Corporation, Carnegie Building, Pittsburgh, Penn.

Obituary

E. C. Meier, president of the Heine Safety Boiler Co., died of heart failure at the Manufacturers' Club, Philadelphia, Tuesday afternoon, May 7, aged 50. Mr. Meier was attending a meeting of officials of the Emergency Fleet Corporation for which his company is making many boilers.

Personals

E. E. Maher has been appointed Chicago district manager of the Terry Steam Turbine Co., with offices at 1328-29 McCormick Building.

Norman G. Reinicker, formerly with the New York Edison Co., is now with the Du Pont interests in charge of the power plant at Nashville, Tenn.

John D. Stout has been appointed New York district manager of the Terry Steam Turbine Co. Mr. Stout has been assisting Mr. Herbert, formerly in complete charge of the district, but who will now have to devote his entire time to navy and marine requirements.

W. W. Erwin, for the past 18 years connected with the New York Edison Co., successively as mechanical draftsman, chief draftsman and superintendent of construction, has been appointed chief operating engineer of the company to succeed the late J. P. Sparrow.

The Association of Iron and Steel Electrical Engineers announces the following meetings: The Cleveland District Section on May 25 at Hotel Statler. A. E. Hogrebe will discuss the subject of Cranes. The Philadelphia Section will meet on June 15 and will hold its annual outing on this date at Valley Forge to take the place of the regular monthly technical session.

Engineering Affairs

The American Society for Testing Materials will hold its twenty-first annual meeting at Atlantic City, N. J., June 25-28, with headquarters at the Hotel Traymore.

The National Association of Master Steam and Hot-Water Fitters will hold its twenty-ninth annual convention in Chicago, June 3-5, with headquarters at the Hotel Sherman.

The American Society of Heating and Ventilating Engineers will hold its summer meeting at Buffalo, N. Y., June 26-28. This meeting is being held earlier than usual, partly to accommodate the members of the National District Heating Association, which association will not hold a meeting this year.

The American Society of Mechanical Engineers will hold its spring meeting at Worcester, Mass., June 4-7. The meeting will open and registration take place at the Hotel Bancroft on Tuesday forenoon. Wednesday will be New England Day. In the forenoon George H. Haynes will read a paper on "The Small Industry in a Democracy," and J. E. Rousmaniere one on "The Textile Industry in Relation to the War." These will be followed by visits to Crompton & Knowles Loom Works and to the plant of the Royal Worcester Corset Co. In the afternoon papers will be presented upon subjects relating to New England's industries under war conditions, and the following at the general session: "Foundry Cost and Accounting System," by W. W. Bird; "The Public Interest as the Bed Rock of Professional Practice," by Morris L. Cooke; "Moisture Re-absorption of Air-Dried Douglas Fir and Hard Pine, etc.," by Irving H. Cowdrey; "A High-Speed Air and Gas Washer," by Lieut. J. L. Alden; "Investigation of the Uses of Steam in the Canning Industry," by J. C. Smallwood. On Thursday forenoon at the general session will be given the following papers: "Efficiency of Gear Drives," by C. M. Allen and F. W. Roys; "Self-Adjusting Spring-Thrust Bearing," by H. G. Reist; "Air Propulsion," by Morgan Brooks; "The Elastic Indentation of Steel Balls Under Pressure," by C. A. Briggs, W. C. Chapin and H. G. Heil; "Electric Heating of Molds," by Harold E. White; "Stresses in Machines When Starting or Stopping," by F. Hymans. At the Fuel Session the paper will be: "An Investigation of the Fuel Problem in the Middle West," by A. A. Potter, and topical discussion on fuel economy, to be arranged for by the Fuel Conservation Committee of the Engineering Council. The various sessions will be held at the Worcester Polytechnic Institute.

Miscellaneous News

A Boiler Exploded at the Houston and Texas Central Railway shops at Ennis, Tex., on Apr. 13, killing one young man and seriously injuring another man.

Watervliet Arsenal is in urgent need of machinists for the conduct of its establishment and calls for the assistance of all instrumentalities which are available. One thousand skilled mechanics must be procured before Sept. 1. The character of the work and the high rates of pay should prove attractive to machinists.

Although 6600 Volts of electricity apparently passed through the body of John Hanifan, a lineman for the Virginia Western Power Co. at Ronceverte, he survived. When Hanifan's foot slipped his body came in contact with the high-power wire and a monkey wrench he carried came in contact with a guy wire, establishing a circuit. The "circuit-breaker" in a substation worked promptly, shutting off the current.

The Potomac Light and Power Co., of Martinsburg, W. Va., according to the statement of a man connected with the company, is expending $250,000 for machinery and transmission lines for a plant at Dam No. 5 on the Potomac River, about 10 miles northwest of Martinsburg. By the improvements to be made the company expects to increase its capacity 2500 hp. In addition to the steam-power plant at Martinsburg, a plant will be built at dam No. 4 and negotiations have been completed with the Hagerstown & Frederick Railway Co. under the terms of which the latter company will use the surplus power of the Potomac company when needed, and vice versa.

Business Items

The Clarage Fan Co., of Kalamazoo, Mich., announces the removal of its Chicago office to the Conway Building, 111 West Washington St., Room 1666, with Gardner J. Thomas in charge.

The Sprague Electric Works, announces the removal of its St. Louis office from the Chemical Building to the Pierce Building, Room 1352; and the removal of its Boston office from 201 Devonshire St., to 84 State St., Room 906.

The Alberger Pump and Condenser Co. announces the election of its officers as follows: Chairman of the Board of directors, George Q. Palmer; president, William S. Doran; vice-president, William R. Wilson; secretary, Richard C. Williams; treasurer, Frederick A. Brockmeir.

The Vulcan Soot Cleaner Sales Co.'s removal of main offices from Chicago to Du Bois, Penn., does not affect the Vulcan Fuel Economy Co., which controls boiler-room and fuel-conservation appliances, and remains at 230 South La Salle St., Chicago, with representatives in the chief manufacturing centers.

The Havard Coal Meter, which has been in general use for a number of years for measuring coal in boiler rooms as fed to boilers, has been awarded the Certificate of Merit by the Franklin Institute of the State of Pennsylvania. The award reads as follows: "In consideration of the invention of a meter for the measurement of granular material, which combines simplicity of construction with reliability in operation, is automatic in action and accurate in measurement within a reasonably small limit, the Institute awards the Certificate of Merit to Oliver D. Havard, of Allentown, Penn., for his invention of The Havard Coal Meter.

Trade Catalogs

A Business Trip With a Railway President. Perolin Railway Service Co., St. Louis, Mo. Pp. 16; 9 x 12 in. The story of Perolin as a boiler-metal treatment attractively presented as a drama in three acts, under the above title.

Lower Pumping Costs with E-M Synchronous Motors. Electric Machinery Co., Minneapolis, Minn. Bulletin 183. Pp. 23; 8½ x 11 in.; illustrated. Outlines in a general way the subject of centrifugal-pump development; the selection of a motor to drive a pump, etc.

The Smooth-On Manufacturing Co., of Jersey City, N. J., will send to anybody who requests it, a copy of the 16th edition of its new instruction book, which contains 144 pages of interesting and illustrated reading matter, showing how the different Smooth-On iron cements are used for repairing purposes.

NEW CONSTRUCTION

Proposed Work

N. H., Manchester—The Manchester Traction, Light and Power Co. has had plans prepared for the erection of a boiler house near Mast St. L. J. Farrell, Engr.

N. Y., Albany—The Chasm Power Co. of Chateaugay, plans to issue $25,000; the proceeds will be used to build an auxiliary power house and install and equip same with necessary machinery. W. T. Thayer, Gen. Mgr.

N Y., New York—The United Electric Light and Power Co., 515 West 141st St., has purchased a site on West 97th St. and plans to build a power station on same.

N. Y., Utica—The Augusta Knitting Mills, 307 Niagara St., will soon award the contract for the erection of a 2 story factory. Estimated cost, $30,000. Motors, blowers, etc., will be installed in same.

N. J., Newark—The Heller and Merz Co., Hamburg Place, will soon receive bids for the erection of a power house. R. G. Corey, 39 Cortland St., New York City, Arch.

Md., Cumberland—The Kelly Springfield Tire Co., Cook St., Akron, is building a new plant here. Work includes the construction of a power station. Estimated cost, $1,000,000.

W. Va., Charleston—The Virginia Power Co. plans to build a 16 mile transmission line from here to Nitro. H. G. Scott, Gen. Mgr.

W. Va., Harpers Ferry—The Northern Virginia Power Co. plans to issue $500,000 bonds; the proceeds will be used to build a hydro electric plant. D. M. Swink, Winchester, Va., Gen. Mgr.

Ga., Reidsville—City voted to issue $10,000 bonds for the installation of an electric lighting plant.

Fla., Sarasota—City plans to install an electric lighting and power plant.

Ala., Goodwater—The Central of Georgia Ry. plans to build a coal chute and install electric power equipment. C. K. Lawrence, Ch. Engr.

Miss., Purvis—City will soon receive bids for the erection of an electric lighting plant. X. A. Kramer, Magnolia, Engr. Noted May 7.

La., Gueydan—City plans to install an electric lighting plant. About $15,000 is available for the project.

Ohio, Cincinnati—The Andrews Steel Co. 9th and Lowell Sts., Newport, plans to build a 6000 kw. electrical unit at its plant. W. N. Andrews, Secy.

Ohio, Cleveland—The Army and Navy Post, Grand Army of the Republic, care J. J. Sullivan, Central National Bank, Rockefeller Bldg., plans to build a memorial building and install low pressure boiler for steam heat.

Ohio, Cleveland—The J. P. Stotter Co., Leader News Bldg., plans to build a hotel on Euclid Ave and East 71st St., and install elevators, heating boilers, etc. Total cost, $200,000.

Ohio, Columbus—City is having plans prepared for the installation of a new heating system in the city hall. About $19,000 has been appropriated for this project.

Ohio, Gambrinus—(Canton P. O.)—The Wheeling and Lake Erie R. R., Electric Bldg., Cleveland, plans to build power and round houses here. About $95,000. W. R. Rohbock, Electric Bldg., Cleveland, Engr.

Ind., Indianapolis—The Citizens Gas Co., 47 South Penn St., plans to improve and extend its plant. Estimated cost, $750,000.

Wis., Peshtigo—T. A. Pamerin has purchased the local electric lighting plant and plans to install additional equipment and build a dam.

Wis., Stevens Point—The Jackson Milling Co., Grand Rapids, plans to build a 2 story, hydro electric plant. About $500,000. L. A. Geers, Grand Rapids, Engr.

Iowa, Monticello—The Monticello Electric Co. plans to extend its electric transmission lines from here into Linn County. G. Adamson, Ch. Engr.

Kan., Alden—N. L. Jones has been granted a franchise by the City for the construction, maintenance and operation of an electric light and power distributing system.

Kan., Garnett—City plans an election to vote on $65,000 bonds; the proceeds will be used to improve its electric lighting plant and water works system. Black & Veatch, Inter State Bldg., Kansas City, Mo., Engrs.

Kan., Topeka—The St. Frances Hospital will soon award the contract for the erection of a brick and reinforced power house and laundry. Estimated cost, $20,000. E Forsblom, Topeka, Arch.

Neb., Norfolk—The Board of Directors of the State Insane Hospital, will soon award the contract for the erection of a power house and ward building. Estimated cost, $70,000. J. C. Stitt, Arch.

Mo., Kansas City—The Kansas City Railways, 303 Montgall St., will soon award the contract for the erection of a substation on Oak St. Estimated cost, $25,000. C. E. Fritts, 15th and Grand Ave., Engr. Noted Oct. 7.

Mo., Lees Summit—The Green Light and Power Co. plans to extend its transmission lines from here to Little Blue.

Mo., West Plains—The Missouri Iron and Steel Corporation plans to build a large power plant near Henderson. Estimated cost, $750,000.

Tex., Denison—City plans to build an electric lighting plant.

Tex., Nixon—The Nixon Electric Light and Power Co., plans to install an alternator. W. L. Hoover, Mgr.

Okla., Bixby—City plans to install an electric lighting plant.

Okla., Jennings—City plans an election soon to vote on $25,000 bonds for an electric lighting plant.

Ariz., Snowflake—The Snowflake and Taylor Irrigation Co. plans to build a hydro electric plant. Plans for the project will mature about July 8.

Wash., Seattle—The Board of Public Works plans to build a sanatorium and will install a steam heating plant in same. About $60,000. A. H. Dimock, City Engr.

Ore., Estacada—The Portland Ry. Light and Power Co., Portland, has been granted permission by the Government to build a large power plant and dam here. About $1,000,000. O. B. Coldwell, Bway and Alder Sts., Portland, Gen. Supt.

Ore., Salem—The Crown Willamette Paper Co., Pittock Blk., Portland, has applied for permission to develop 200 second feet of water from Youngs River, near Astoria. Plans include the construction of a power house, dam, etc. Estimated cost, $150,000.

Ore., Toledo—The Lincoln County Light and Power Co. plans to enlarge its capacity by installing a 2000 hp. turbine and dynamo. J. Paquet, 112 East 12th St., Portland, Pres.

Calif., Modesto—The Sierra and San Francisco Power Co. plans to build a hydro electric plant on the Middle Fork of the Stanislaus River. M. C. McKay, 58 Sutter St., San Francisco, Supt.

N. S., Barrington—The Town plans to build an electric lighting and power plant. Estimated cost, $8000.

N. S., Berwick—Town plans to build an electric lighting and power plant. H. A. Cornwell, Clerk.

N. B., St. John—T. McAvity and Sons, Ltd., plans to install a new 550 hp. steam power plant in its plant now being built.

Ont., Hamilton—The Board of Governors of the City Hospital has plans under consideration for the construction of a power plant here.

Ont., Toronto—Milton & Prentice Traders' Bank Bldg., is in the market for two 250 hp. vertical steam engines.

CONTRACTS AWARDED

Mass., Middleton—Essex County Commissioners, Salem, have awarded the contract for the installation of a central heating plant, to Lynch & Woodward, 287 Atlantic Ave., Boston. Estimated cost, $35,764.

R. I., East Greenwich—The Andrews Mill Co., 221-4th Ave., New York City, has awarded the contract for the erection of a 2 story, 45 x 80 ft. brick and steel power house and a brick and steel weave shed, to be erected here, to the C. I. Bigney Constr. Co., 89 Weybosset St., Providence. Estimated cost, $200,000.

Conn., Bridgeport—The United Illuminating Co. has awarded the contract for alterations and improvements to its local power house, to the New England Iron Works, 94 Commerce St., New Haven.

N. Y., Buffalo—The Delaware, Lackawanna and Western R.R. has awarded the contract for the erection of a power house at East Buffalo, to J. W. Cowper, Fidelity Bldg.

N. Y., Mohawk—The Elastic Spring Knit Corporation, East Main St., has awarded the contract for the erection of a knitting mill to F. R. Edick, West Main St. Estimated cost $30,000. A steam heating plant will be installed in same.

Penn., Erie—The Board of Education has awarded the contract for the erection of a new school, to Sutherland Building and Contracting Co., Syndicate Trust Bldg., St. Louis. Boilers and a vacuum heating system will be installed.

Del., Wilmington—The Mullins Store Co. has awarded the contract for the installation of a heating plant, to Gawthrop & Bro. Co. Estimated cost, $11,270.

Va., Richmond—The Virginia Ry., and Power Co. has awarded the contract for improvements and alterations to its sub station, to Nicholas & Lindermann, 522 Sea Board Blk., Norfolk. Estimated cost, $11,700.

Ohio, Hamilton—The Shuler and Benninghofen Mills Co., Lindenwald St., has awarded the contract for the erection of an addition to its boiler house, to G. Lingler. Estimated cost, $7500.

Neb., Sidney—The Town has awarded the contract for improvements to its electric lighting and water works plant, to the O'Fallan Supply Co., Denver, Colo. Estimated cost, $30,592.

Ariz., Snowflake—The Snowflake and Taylor Irrigation Co. has awarded the contract for the installation of an electric lighting and power plant, to H. T. Loyd, Wickenberg. Noted Oct. 16.

Wash., Cheney—F. M. Martin Grain and Milling Co., Hutton Bldg., Spokane, has awarded the contract for the erection of a concrete mill to Huetter Construction Co., Spokane. Equipment including motors, electric lighting outfit, etc., will be installed.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	.....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	.....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$2.80	$4.35	$3.70
Barley	2.15	1.50	2.40	1.75
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.65-3.25	$2.65-2.80	$2.65-2.80
2-in. lump	2.65-3.00	2.65-2.80	2.25-2.50
Steam egg	2.65-2.80	2.35-2.50	2.25-2.40
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.40	2.15-2.40	2.15-2.40
No. 5 washed	2.15-2.50	2.15-2.35	2.15-2.35

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.